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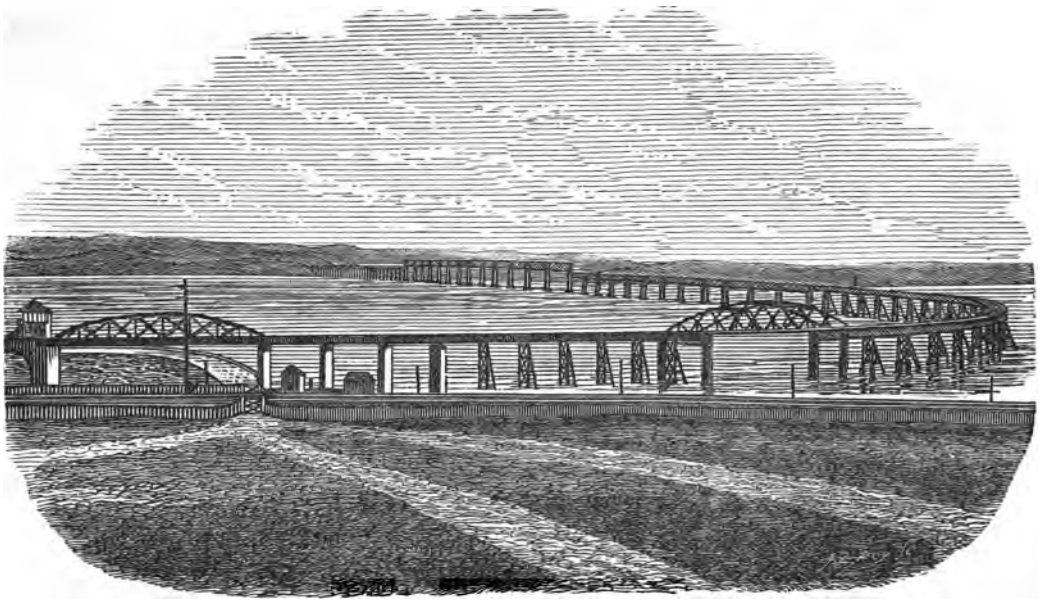

VIEW OF THE TAY BRIDGE FROM THE NORTH. From Photograph by J. VALENTINE, Dundee.

THE TAY BRIDGE:

ITS

HISTORY AND CONSTRUCTION.

The Introductory Note and Lithograph Drawings

By ALBERT GROTHE.

PRINTED BY JOHN LENG & CO., BANK STREET.

1878.

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INTRODUCTORY NOTE.

THE most notable difficulties in connection with the construction of the Tay Bridge were caused by the boisterous character of the weather in the river, and the nature of its bottom. Each of these circumstances by itself would have rendered the use of ordinary scaffolding and staging impracticable. Had this not been the case, the cylinders might have been built, lowered, and steadied from a reliable staging, and the girders, during their erection, rested on secure scaffolding till they were finally connected to the piers. Everything would thus have been plain and straightforward. No unpreventable accidents would have happened, and cost, as well as time of completion, would have been predicted to a nicety. The Bridge would only have differed from a thousand similar structures all over the world by the fact that it is the longest of them all.

E.J.K.
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As it was, new methods of construction had to be invented and tried, sometimes at considerable expenditure of time and money. It is, of course, not possible to build two bridges precisely on the same pattern, and modifications have to be introduced to suit different circumstances. But in the methods employed at the Tay Bridge there are many which had never before been used, and these possess a high interest for the professional engineer and the general public. Most of them are accurately described in the succeeding pages, and others will be understood by referring to the drawings at the end of this little volume. The

writer deserves great credit for the lucid and accurate description, which is as complete as consistent with a non-technical work. A few words may, however, be added explaining the lifting of the girders to their proper height. The 245 feet girders were treated in a different manner from the others. The two girders composing one span were fixed together at their proper distance from each other previous to floating out, and all the cross girders and bracings, with the exception of those at the ends, were put in. They were deposited on the piers when these had reached a height of 5 feet above high water. The vertical end-posts had a temporary lifting bar of T iron fixed to them, running the whole length from bottom to top beams. At a uniform distance of 1 foot holes of $3\frac{1}{4}$ inches diameter were bored. The lifting platforms were bolted to the columns at a distance of about 20 feet from each other, the bottom one being that height above the pier. As the girders themselves are 27 feet deep, this lifting platform would be lower than the top of the girders, and stand between them. A transverse beam of iron was placed on the lifting platform, and on this beam stood two hydraulic jacks of 7 inches diameter, carrying in their turn another transverse beam. Steel pins were now inserted in those holes of the vertical T bars nearest to the top transverse beams, and the rams pumped up, lifting these beams, and with them the whole girders. When the rams were out to their full lengths (a little more than 12 inches), a pin was put in the hole then just above the lower transverse beam, and the water pressure was withdrawn, so that the rams with the top beam came down 12 inches, the weight of the girder resting on the lower beam in the meantime. After this the operation recommenced, and was continued till the girders were as high as the lifting platforms, and

then another twenty feet of columns were erected, from which the further raising of the girders could proceed.

The 146 feet and 130 feet girders were floated out also in sets of two, but they were not permanently fixed to each other, but kept at a wider distance, so as to stand outside the columns on which they had finally to rest. They were thus lifted singly from the top of the pier and slung into their proper positions, after which the permanent connections were put in. The minute description of the process for the larger spans, together with the drawing, will enable the reader to follow this process without any difficulty.

Some misconception seems to exist respecting the circumstances attending the transfer of the contract from Messrs de Bergue & Co. to Messrs Hopkins, Gilkes, & Co., and although it may not be very important to the general public, it is as well that it should be cleared up. Messrs de Bergue & Co. performed their work as efficiently and expeditiously as any contractors could have done. It was solely due to financial complications consequent on the death of the sole partner of the firm, Mr Charles de Bergue, that the subscriber, then one of the managers of that firm, negotiated and obtained a release from the contract by the Company. During the three years they held the contract not so much was done as during the subsequent three years and a half until the completion of the work. But this was due to the fact that the work was much more difficult to perform than was anticipated, as the nature of the river bottom turned out to be quite different from what the official borings had given reason to expect. The plans for the foundations and piers had to be materially altered, contracts for ironwork had to be undone and new ones entered into, plant had to be made to suit the altered method of working. It was not until the preparations

had been completed that the work proceeded rapidly; and from August 26th, 1875, until completion, the work could be done with great precision. The programme made out at that time was carried out from month to month, and the Bridge completed at the period fixed a year and a half before.

As is known, the plans of the Bridge were prepared by Mr Thomas Bouch, the Company's Engineer. The *modus operandi* for its construction was left to the Contractors. The first principles on which it should be done were laid down quite in the beginning by Mr Edward R. Austin, co-Manager with the subscriber for Messrs De Bergue & Co. These principles of floating piers and girders have been adhered to, with such modifications as the altered plans required. Under the second contract—executed by Messrs Hopkins, Gilkes, & Co., of which Mr Edgar Gilkes is Managing Director and Superintendent of the works—the plant and appliances were designed in the Contractor's office by a most efficient and enthusiastic staff of young engineers. Mr Reeves invented the sand pump, which did so much to facilitate the work. Several clever methods were introduced by Mr G. W. Camphuis and the Messrs Delprat. Mr T. C. de Bruyn and Mr Frank Beattie did not stay on the work until its completion, but to them also a great deal of success is due—to the latter particularly, in the scheming of the appliances for lifting the 245 feet spans to their resting-place 88 feet above high water.

ALBERT GROTHE.

DUNDEE, *June* 1878.

THE TAY BRIDGE.

PRELIMINARY PLANS AND PROCEEDINGS.

INTRODUCTORY.

The use of iron in the construction of bridges is of a date so recent that it was not until the year 1776, when Mr Abraham Darby, of the Coalbrookdale Iron Company, conceived the idea of throwing an iron bridge across the Severn, and realising it in 1779, that the experiments made towards this end resulted in success. Since then some very substantial and even beautiful structures have been erected—notably Burdon's bridge across the Wear at Sunderland, and that with which Telford has spanned the Severn at Buildwas—the plates for which were also cast at Coalbrookdale. When increasing trade required greater facility for the transport of goods and the conveyance of passengers, the arch was found inadequate to carry a roadway over an arm of the sea, or a broad and swiftly-flowing river. Accordingly the idea of suspending a roadway from chains carried over the tops of massive towers, and anchored deep into the earth behind, was realised in a number of suspension bridges which beautify the landscapes and river scenery of our own and other lands. The chief of these is the one which has been thrown across the Niagara immediately above the Falls, and uniting the Dominion of Canada with the United States of America. The span of this imposing structure is 822 feet; the elevation of the roadway being 250 feet above the surface of the stream. Perhaps the most important structure of this class in Britain is that which spans the Avon at Clifton, a suburb of Bristol. It has a span of 703 feet, and is one of the most striking examples of engineering with which the genius of Brunel has enriched the country. It was, however, soon found that the legitimate use of suspension bridges was the carrying of

ordinary roads over large spans, where the loads were not so great nor the motion so swift as that with which we are familiar on railways. Some other form of roadway had, therefore, to be found; and when, in 1845, the younger Stephenson was employed to carry the Chester and Holyhead Railway across the Menai Strait, he proposed to effect his purpose with a circular tube supported by chains. The idea was as bold as it was original; but travellers know that the Britannia and Conway Bridges are rectangular tubes resting upon massive piers, without the least support from chains or any similar contrivance, and this form is the result of a series of remarkable experiments conducted by the elder Fairbairn for the purpose of determining the respective strengths of the various forms of tube which presented themselves to the minds of these eminent engineers. The success of the Britannia and Conway Bridges led to the construction of many similar, the chief of which is the Victoria Bridge over the St Lawrence, near Montreal, the first stone of which was laid on the 20th of July 1854, the first train passing through it on the 7th of December 1859. Its length is 9114 feet—1 mile 5 furlongs 34 poles and 1 yard. It is said that 9000 tons of iron were used in the construction of the tubes, while the total cost was £1,400,000, or about £153 per lineal foot. In reality such bridges are nothing more than long iron tunnels supported on piers, and those who have never seen them may have an almost exact impression of their appearance by looking along the thirteen large girders which form the centre of the Tay Bridge. At present a person walking along the platform of these girders has the feeling that he is enjoying a walk through a long delightful avenue; but cover their tops and the lattice work of their sides with solid plates of iron, and then the trains would rush along in the dark as they do now through the Victoria tube which the genius of Stephenson and Ross has laid across the magnificent St Lawrence. Successful as these bridges were, the waste of material was too great to allow engineers to rest in the idea that nothing more required to be done; and it was ultimately found that the lattice girder which Mr Bouch has adopted in the construction of the Tay Bridge would be as strong, and, by presenting a less surface to a gale, as secure; while the consumption of material is so much less that the cost of the wondrous structure

which unites the shores of Fife and Forfarshires will be as a mere bagatelle when compared with that of its Canadian rival.

ITS CONCEPTION.

It is to Mr Bouch, when Engineer and Traffic Manager to the Edinburgh, Perth, and Dundee Railway Company, that the bold design of bridging, not the estuary of the Tay, but also that of the Forth, is due. In his official capacity he had frequently been a witness of the inconvenience and danger attendant upon the working of the Ferries at Tayport and Burntisland, and a fatal accident occurring at the latter place in 1849 quickened his perception of the costliness and clumsiness of the system then in practice, while it led directly to his conception of the design, which has in part been wrought out in the construction of another "wonder of the world," with which the people of Dundee are already familiar. It could not be diffidence in his own powers which led Mr Bouch to keep his own counsel for the next five years; but, from whatever cause, it was not until the summer of 1854 that he astonished the Directors of the Scottish North-Eastern Railway, who were then in London, by propounding a scheme for bridging the Friths of Forth and Tay, and expressing his determination, if he lived, to carry it, or something analogous to it, into execution. Although the promoters of the Victoria Bridge, of which we have already given the reader an idea, were at this very time about to lay its foundation-stone, Mr Bouch was looked upon as a dreamer, and treated with an incredulity which was strangely inconsistent with the character of astute business men, whose knowledge of what the engineers had already accomplished ought to have given them some conception of the resources which man may command to aid him in his conflicts with Nature. But the Engineer knew that his plan would keep, and as every year was witnessing engineering triumphs which were only possibilities the year before, he bided his time, and waited with patience until those who could command the cost should see eye to eye with him. But the seed he had scattered around him did not all fall upon stony ground. The process of germination was indeed slow; but friendly hands gave it an occasional watering, and when, in 1863, the young braird began to show itself,

"Hope sprang exultant on triumphant wing."

FIRST PRIVATE MEETING OF THE PROMOTERS.

The local and Parliamentary history of the Tay Bridge undertaking unhappily bears too much resemblance to that of all great schemes of improvement. The narrative is full of conflicts, struggles, obstructions, and hindrances. Now that the Bridge is a splendid fact, it is painful to recall the multitudinous doubts and difficulties that were conjured up against its practicability, and the impassive indifference of many, which was worse to get over than the vigorous opposition of a few. But for the calm self-reliance of Mr BOUCH, the Engineer, and the indomitable energy of Mr THORNTON, the Solicitor for the undertaking, who fought many a hard battle to secure its success, the Bridge would probably not have been accomplished for years to come. It was at a meeting called by Mr THORNTON, and held on the 9th October 1863 in his office, that the first important step was taken in connection with the scheme, and it is worth recording that those present were Provost PARKER, Messrs JAMES NEISH, PETER HEAN, JAMES YEAMAN, W. W. RENNY, THOMAS BELL, and JOHN BERRY; Mr THORNTON, and Mr DODDS, Parliamentary Solicitor, of London. Of these nine four are now deceased, Provost PARKER till the day of his death being pre-eminent in his devotion and fidelity to the scheme.

FIRST PUBLIC PROPOSAL OF THE SCHEME.

The first public expression of a belief that the Storm Fiend of the Tay might be met on his own domain and successfully defied was made in the *Dundee Advertiser* on the 6th November 1863. In an article entitled "The Bridging of the Friths" the writer described the roundabout manner in which Dundee was approached from the south, and suggested the spanning of the Tay from the lights above Tayport on the south to the Harecraigs on the north. Entire confidence was expressed in the practicability of such an undertaking; and the writer proceeded—"In the presence of the great things which have been done in tubular and suspension bridges in America and in Wales, we can see no serious difficulties in the way of bridging the Tay. The bottom of the river is, like that of the St Lawrence, of rock; the hills on the river side are

steep—a favourable circumstance; and the present annual cost of the Tay Ferries is so incredibly heavy that it would, we should suppose, go far to pay the interest on the whole sum required for the work. Judging from what we know of the locality, the things most important for the formation of a great high-level bridge—viz., a good foundation and convenient side elevations—already exist. In the formation of the monster bridge over the St Lawrence the engineer had to contend with a rushing current, with the annual formation of ice from four to five feet thick, and with the heaping up of that ice into drifting bergs. . . . . It seems strange that a nation, whose lifetime has not yet equalled that of some of its oldest citizens, should thus have completed architectural works worthy of the ambition of Imperial Rome, and it suggests to us the question—why, if the Americans, in their half-cultivated country, have achieved so much, we, in this old and rich and compact little island, should hesitate to throw a bridge over the Tay. That the business begins to press is acknowledged by all who feel the insular position of our eastern towns, and that the requisite work might now be completed far more economically than were the experimental structures will be acknowledged by all engineers."

FIRST PARLIAMENTARY PLAN—1864-65.

Scarcely a year later (18th October 1864) the *Advertiser* had the pleasure of announcing the intention of the promoters to apply for a Bill to sanction the construction of a bridge across the Tay. The plan to construct the bridge between Newport and the Craig Pier was adopted. At this point the Tay was to be crossed in 63 spans. At the fair way the height was to be 100 feet above the level of high water; and before the Dundee side was reached this height was reduced to between 25 and 30 feet. Instead of curving to the east, as it now does, the direction was to the west; and the junction with the Perth line was to take place at the east end of the Magdalen Green. In connection with the bridge a General Station was to be constructed on the high level, on ground reclaimed from the river, and very near the position occupied by the now nearly finished low-level station of the North British Railway Company. On the 26th of the same

month a public meeting in favour of the undertaking was convened in the Town Hall. This meeting, at which Provost Parker presided, was organised by Mr Thornton, who has been the agent for the undertaking from the beginning, was addressed by Mr Dodds and Mr Bouch, and was certainly one of the most influential which had ever been convened within the Council Chamber. The unanimous resolution, "That it would be for the public advantage, and tend greatly to the development of the traffic of the North of Scotland, and especially of the Town and trade of Dundee, were the present inconvenient and expensive route to the south improved by the construction of a bridge over the river Tay; and were suitable provision made for a General Passenger Station at Dundee" showed that, whatever might be the fate of the Bill about to be laid before Parliament, the undertaking would no longer suffer through popular incredulity—indeed, what was most to be feared now was the active opposition of the Town Council and the Harbour Board; and, perhaps most reprehensible of all, the supineness of lukewarm friends.

CHANGE OF PLANS.

On the 4th of November 1864 the prospectus of the Tay Bridge and Union Railway appeared. The capital was stated at £350,000, in 14,000 shares of £25 each, and the Provisional Committee contained an ample representation of the wealth and enterprise of the community. On the 15th of the same month the Parliamentary Notice of a Bill to provide for the incorporation of a Company was given. The Bill also provided for the construction of the Bridge and its connecting lines, and, *inter alia*, gave power to the North British to subscribe to the capital of the new Company, and also invested it and other Companies with power to enter into agreements and to raise money. It has been said that the position selected for the Bridge was from Newport on the south to the Craig Pier on the north; but, anxious to prevent the least encroachment upon the privileges of the Harbour, and to conciliate as far as possible the members of the Harbour Trust, the Engineer selected a position considerably further west, and the amended plans showed that such position was at a point about 200 yards west of Woodhaven on the south, and at Buckingham Point on the north. It was to be

approached from Tayport by a railway of over four miles in length. It crossed the Tay in 80 spans instead of the 63 which would have been necessary had the position between Newport and the Craig Harbour been selected; and the total length of these 80 span was 8130 feet, or 1 mile 4 furlongs 12 poles and 4 yards. On approaching the Magdalen Green it curved past Buckingham Point, as the present Bridge does, and terminated in a high-level station which was to be erected on the solum nearly opposite the Foundry of the Caledonian Railway Company, at the foot of Seabraes. From this General Station a short line ran westward until it joined the Dundee and Perth Railway opposite the Vine, the residence of the late Mr George Duncan; while the Union line proceeded eastward on the high level, and crossed South Union Street at a height of 16 feet to the south of the present railway offices there. Passing through the block of buildings which forms the east side of this street it reached Dock Street at the premises occupied by the Working Men's Coffee House. Crossing Dock Street at this point, it entered upon the Town's property on the north, and passing eastwards behind the warehouses took the Greenmarket just south of the drinking fountain at a single span. Entering upon the property to the north of the Crown Hotel, and passing behind the London Shipping Company's Offices and Shore Terrace, it reached Castle Street, which it crossed at what was then the office of Bailie Webster, but is now the shop of Mr Nicholson, brushmaker. From Castle Street it proceeded in a straight line behind Exchange Street, and until Gellatly Street was crossed about 250 feet from Dock Street. From this point it curved south towards the Arbroath line, and, crossing Trades Lane about 150 feet from its south end, passed through what was then open ground to Dock Street, which it crossed at the foot of Whale Lane. There was, however, an alternative at this point by which it might have been carried eastward along the north of Dock Street until it joined the Arbroath line at a point opposite Craigie Cliff, the residence of Mr Yeaman, M.P.

THE FIRST BILL AND FIRST DIRECTORS.

The scheme was prosecuted with hopeful energy. Meeting after meeting of a Managing Committee of the Provisional Committee

took place under the presidency of Provost Parker. The necessary Parliamentary Notice of the Bill was published in November 1864, and the Bill itself deposited in Parliament in December, with the following as the first Directors, viz. :—Chas. Parker, Esq., Provost of Dundee ; James Kennedy, Esq., Dean of Guild of Dundee ; David Hunter, Esq. of Blackness ; Joseph Grimond, Esq., merchant, Dundee ; John Berry, Esq. of Tayfield ; and John Kirkland, Esq., merchant, Dundee. Nor were these gentlemen and other friends wanting in the courage necessary to prosecute so great an undertaking. They not only subscribed as shareholders, but a deposit of £30,000, required by the standing orders of Parliament, and raised through the chief promoters, was lodged in Bank in name of Provost Parker, Mr Adam of Blairadam, Dean of Guild Kennedy, and Mr A. D. Grimond.

THE TOWN COUNCIL ON THE WATCH.

Such was the undertaking which had been so fully considered, and so judiciously and hopefully presented to the public. There was still a considerable number who, possessed with grave doubts as to its *bona fide* nature, looked upon it as a strategical manœuvre of the North British to bring opposing interests into harmony with their designs elsewhere. The promoters could afford to pass the headshakings and the sneers of these unheeded ; but the attitude of suspicion assumed by the Town Council, and the threatened active opposition by the Harbour Trust were ominous of hard words, of elaborate reports, and expensive deputations. The Town Council did not object to the construction of the bridge, but they desired that a footway for passengers should be combined with it—that the trains should be arranged to suit the convenience of the public, and that the fares should be fixed at a rate within reach of the whole community. To prevent an undue use of proprietorial rights they also desired that other Companies should have an interest in the works so far as to enable them to use the bridge on agreement with the constructing Company. To the Union line, however, they had serious objections, more especially to the high-level railway a mile and a quarter in length between the town and the river.

NON-COMPROMISING ATTITUDE OF THE HARBOUR BOARD.

But in the opposition of the Harbour Trust there was scarcely a redeeming feature. Provost Parker, Dean of Guild Kennedy, and Bailie Yeaman became shareholders with the honourable intention of promoting alike the interests of the Burgh and Harbour in connection with the realisation of a noble undertaking, but it was soon apparent that these intentions were misconstrued. The votes of Provost Parker and his friends in all matters connected with the Tay Bridge undertaking at the Harbour Board were challenged as illegal, and the Provost himself threatened to be unseated as Chairman of the Board. It was not till after Mr Thornton had taken and produced the opinion of the then Lord-Advocate of Scotland on the subject that that mode of endeavouring to stifle healthy action was frustrated. We think Bailie Yeaman might have asserted his independence without turning his back so completely as he did upon his co-dignitaries in the magistracy, causing them great personal annoyance and anxiety. As it was, the proposal of Mr Bouch to modify his plans so as to meet the objections of their own Engineer, or of the promoters to insert clauses to protect the navigation of the river, and to provide an esplanade for the use of the inhabitants of Dundee, did not meet with even a moment's consideration. The bridge stood like a gaunt spectre between the Trustees and their judgment, and, unless they succeeded in exorcising the frightful apparition, the glory of the Dundee Harbour would be nothing more than a mournful reminiscence to their children—if not, indeed, to themselves.

A HOST OF HORNETS.

But these, although the chief, were not the only malcontents. As the construction of the bridge would have given the North British Railway an advantageous, because a direct, unquestioned, and uncontrolled entrance into Dundee, the Directors of the Scottish North-Eastern and Scottish Central were up in arms to prevent their rival from becoming stronger than themselves. Even the Dundee Right-of-Way Association joined the host of hornets which kept buzzing about the ears of Mr Bouch and the promoters of the bridge; while the Perth Town Council, in the interest of their port and a trade in shipping which, whatever might have been its extent in times past, was now rapidly decaying, put in a claim to be heard against the contemplated obstruction of the river.

HOPEFUL PROMOTERS.

There are, however, always some whom no opposition, however powerful, can crush. Despite of all opposition the promoters went on to the Board of Trade. The result was an encouraging report by that Board in favour of the scheme, and consequent preparations to fight the opposition in Parliament. Meeting after meeting had also taken place in Dundee with Committees of the Town Council and the Harbour Trustees. But about the time when the Bill was to enter Committee the North British Company, who had aided the promoters hitherto, and who were then promoting a Forth Bridge scheme, having been approached by their opponents, used their influence with the promoters of the Tay Bridge to postpone their Bill for another session, when they promised to support it with all their power and influence. The consequence was that, willing to make the North British the loyal and powerful ally it afterwards became, and perceiving that the details of the Bridge might be improved, and some of the opponents who were most clamorous thereby silenced, the promoters, in May 1865, cheerfully agreed to abandon their scheme in the then session, with the view of renewing it in an amended form under the name of the North British Company in the session of 1866. Connected with the opposition, the broad features of which have already been sketched, there were many minor details, but the relation of these would be tedious, and might intensify the feeling of regret with which gentlemen still alive ponder over the hallucination which led them to oppose, without qualification, the purpose to bridge the Tay which they have lived to see successfully accomplished.

THE FORTH BRIDGE SCHEME—CHANGE OF TACTICS.

The Tay Bridge Bill withdrawn, the Committee of the House of Commons was hearing evidence on the Bill to enable the North British to construct a bridge across the Forth, when, on the 12th of May 1865, the Scottish Central Directors suddenly withdrew their opposition. This change of tactics on the part of the Scottish Central surprised many who were anxiously watching the contest, but it soon appeared that the opposing Companies had held a parley, the result of which was an immediate suspension of hostilities. This suspension led to an agreement whereby the

Directors of the North British on the one hand agreed to the amalgamation of the Scottish Central and Caledonian Railways, and on the other hand the Directors of the Caledonian agreed—1st, to the amalgamation of the North British and Edinburgh and Glasgow Railways; 2d, to the construction of the Forth Bridge; and 3d, to the construction (next year) of the Tay Bridge. In this way a most influential opposition was neutralised, and the Tay Bridge Bill to be introduced in 1866 was considered as virtually passed. Several important advantages were likely to accrue from the delay thus created. In particular, power would be taken to construct a line from Leuchars to the bridge, and, perhaps, from the bridge to Cupar Fife; while the suggestion of the *Advertiser* to make the bridge itself of a breadth sufficient to carry a double line of rails might receive the attention which it deserved. The period from May to November of this year was the most fruitful in new schemes, and perhaps the most eventful in the history of the two great Scotch Companies. Between them notice was given of no less than twenty-three different undertakings, those relating to Dundee being estimated to cost £1,400,000, which sum, large as it looks, was only a little over a year's revenue of the East Coast Line.

THE SECOND ATTEMPT IN 1865-66—MAGNIFICENT DESIGNS.

On the 15th of November 1865 the promoters, along with the North British Company, gave notice of their second Bill to enable them to construct the Tay Bridge, the Central Station, and connecting lines, and on the following day the Caledonian entered the lists with a Bill to enable them to construct an Esplanade from Craig Pier House to the Magdalen Green, and also a central station with lines to connect it with the Caledonian and Scottish North-Eastern Railways. So far as their schemes relate to Dundee, the position of the contending Companies was now reversed. In the session of 1865 the North British, in determining to construct the Esplanade, and to acknowledge the right which the town held in common with the Crown in the solum of the river, offered Dundee a most magnificent dower. Yet the modest sum of £50,000 which the inhabitants were asked to subscribe to the capital of the Company,

a tenth part (£5000) of which Mr James Cox offered to supply, was withheld. Dundee, in the sulks, was too proud to accept such favours, and spurned the wooer, whose intentions were as honourable as his offers were liberal. This session the North British made a second proposal; but as the town could be approached in another way than through the solum, no offer of an Esplanade was now made, while the Bridge, the Central Station, and connecting lines would be constructed without a penny being asked on behalf of the Company. The Caledonian, on the other hand, adopted the rejected offer of its rival. It was prepared to make the Esplanade, but a covetous eye was cast upon the forty or fifty acres which it would enclose, and power was sought to enable the Town to subscribe towards the completion of the work.

THE CALEDONIAN SEEKS POWER TO INCORPORATE THE SCOTTISH NORTH-EASTERN.

But the Caledonian had yet another and stronger string to their bow. The Scottish North-Eastern would have been a valuable adjunct to the East Coast Line; but the Directors of the Caledonian had already cast their eyes upon it, and arrangements for an alliance which would give them an unobstructed entrance into Aberdeen had been for a considerable time in progress, while in the approaching session a Bill would be introduced to obtain the sanction of Parliament to such arrangements. In adopting such a course the Caledonian did not violate the terms of agreement into which they had entered with the North British a few months before, but they must have known that their success would imperil the construction of the Tay Bridge, to which they then became consenting parties, and throw for a considerable distance into the future the erection of a structure which would greatly facilitate the successful working of their rival's line. The North British took the only course which under the circumstances could be taken when they gave notice of a Bill to enable them to absorb the Scottish North Eastern. They did not, indeed, cherish the hope of being able to carry this Bill, but it would keep the door open through which the Caledonian might be approached or the contemplated amalgamation frustrated.

THE PLANS OF 1866—PROPOSED CENTRAL STATION.

As already indicated, considerable alterations had been made upon the Tay Bridge scheme of 1865. Then the very magnitude of the undertaking created a hesitancy in the public mind as to its probable success. Now, however, Mr Hodgson and his co-Directors accepted the entire responsibility, and, instead of confining themselves to the very handsome proposals set forth in their Bill of 1865, far exceeded them in magnitude and magnificence in 1866. Their plans had been prepared with that care which is characteristic of every work of the kind which emanates from Mr Bouch, and everything which could be thought of had been done to conciliate opponents. This time the Bridge was to be connected, not with Tayport only, but also with Leuchars, and it was to cross the Tay from Wormit Bay on the south to a point considerably west of Binns of Blackness on the north. From that point the line was carried to the high ground over the Dundee and Perth Railway, and, running eastward, recrossed that line, outside of which it ran until it reached Buckingham Point. Here it recrossed again, and to the centre of the town through the gardens attached to the residences on the south side of the Magdalen Yard Road, the Perth Road, and Nethergate ; then, crossing the Sea Wynd, passed through the ground behind St Paul's Free Church, and crossed Union Street to the south of the Thistle Hall. From thence it proceeded through the rookeries between Nethergate and Fish Street, crossed Crichton Street to the south of the Dundee Arms (now Mathers' Temperance Hotel), and ran into a magnificent Central Station, within the area of which the Town House was included. From this central station the route eastward was nearly the same as that set forth in the Bill of 1865 until Dock Street was approached. It was intended to divert this street to the south by the railway, and of this diversion the Harbour Board would have secured spacious quays to the Victoria and Camperdown Docks, thus enabling them to provide extensive warehouse accommodation, and a breadth of street sufficient for whatever amount of traffic might in future be drawn to the Harbour.

WITHDRAWAL OF THE CENTRAL STATION PLAN.

The scheme thus sketched was destined to undergo considerable modifications, and to be shorn of one of the features which recom-

mended it in an especial manner to Dundee. The local bodies were still opposed to any interference with the streets, and looked upon the Railway Directors with a degree of suspicion which was discouraging. But the number, extent, and cost (£12,000,000) of the undertakings set forth in their Parliamentary notices alarmed the shareholders of the competing Companies, and at a meeting of gentlemen connected with the Caledonian, the North British, and the Glasgow and South-Western Railways, which was held in Glasgow on the 21st December 1865, it was resolved to advise the Directors to reconsider their respective schemes, and at the same time to suspend proceedings in carrying out those already authorised. A Committee was also appointed, whose duty it was to adopt ulterior measures should the Directors of the respective Companies fail to carry out the line of policy set forth in the resolutions of the meeting. The influential character of this assembly had great weight with the Directors thus publicly admonished ; and on the 24th of January 1866 a joint-meeting of the North British and Caledonian Directorates was held in Edinburgh, at which both Companies entered into an agreement to mutually withdraw a number of Bills, including those relating to the Central Station in Dundee, and the lines connecting it with the Dundee and Arbroath and Dundee and Perth Railways.

OPPOSING INTERESTS.

This abandonment by the Caledonian Directors of their Dundee Works Bill, and the excision of the Central Station and connecting lines from the plans of the North British, while a severe disappointment to those who saw in the execution of such plans in all their integrity a great advantage to the town of Dundee, nevertheless gave the death-blow to the opponents of the Tay Bridge. Lynx-like the Old and New Gas Companies kept an eye upon number one, and as the promoters were not unreasonable, they and the Harbour Trust could only growl at what they could not avert, and accept such conditions as might be agreed upon in London. The Town Council were, however, unanimous in their support of the Bill. The leaders saw that important advantages might accrue to the Town, and, as Bailie Hay maintained that the solum of the river belonged to the Corporation of Dundee, he was resolved to take advantage of the opportunity thus afforded him, and so

manage that the town should again be put in possession of at least a portion of the river frontage of which it had been deprived by the cupidity of railway schemers and the indifference of former Town Councils. In the matter of the Bridge the North British Directors were in earnest. The expectations of an increase of traffic as the result of its construction were such as to enable them to be liberal in their offers, and Bailie Hay found them as willing to give as he was to take. There was, indeed, a hitch in the negotiations ; but it arose out of a most unusual and unwarrantable interference by the Harbour Board. In order to gain a cheap popularity this Board sent a deputation to London to offer a withdrawal of the Harbour opposition—the price being the construction of the very sea-wall and esplanade which Provost Parker had suggested in 1865. It is impossible to find an excuse for such proceedings. The Harbour Trust were not ignorant of the steps which had already been and were at this very time being taken to protect the interests of the town in the solum ; and although the Trust believed that the sea-wall would greatly benefit the Harbour, yet there were other and very important questions which the Trustees could not approach, and which it was competent for the Town Council alone to settle ; while the facility with which Mr Hodgson and his coadjutors were drawn into the speciously prepared trap was doubtless due to financial considerations arising out of these questions. The agreement signed, the deputation returned to Dundee in high spirits because of the dexterity with which the Harbour had been made to supplant the Town. But their rejoicing was of short duration. They had barely time to settle themselves in their easy-chairs before Bailie Hay let Mr Hodgson know his opinion of the transaction, and assured that gentleman of what as a Railway Director he ought to have known, that an agreement respecting the solum of the river and the construction of the contemplated Esplanade from which the Town of Dundee was excluded could not be allowed. Mr Hodgson saw and acknowledged his mistake, and the Town Council was reinstated in its true position as the guardians of the rights and privileges of the community.

PRIVILEGES CONCEDED TO THE TOWN.

The abandonment by the North British Directors of the Central Station compelled an alteration in the line of connection with the

bridge. We have seen that this line as originally sketched avoided the solum altogether. Now the solum is to be utilised and the bridge line to terminate in a temporary station erected 16 feet above the level of the made-up ground. It was this change of position which gave the Town Council the opportunity of approaching the North British, and which led to the signing of the agreement which had been arranged by Provost Parker and Bailie Hay. By this agreement the Railway acknowledged the right of the town to the solum, agreed to construct a sea-wall between the Craig Pier and Buckingham Point, and to make a street or esplanade the whole length of this wall, the width of which should not be less than sixty feet, and which was to be, when finished, the absolute property of the town. The station and other works were declared to be within the Parliamentary boundaries of the burgh, and subject to all the taxes and other cesses leviable upon the inhabitants; while the fares and arrangement of trains for the bridge line were to be such as would best accommodate the general public.

PERTH STANDS UP FOR ITS FLEET, AND IS SUCCESSFUL.

Dundee satisfied, Perth made a vigorous attempt—not, indeed, to procure terms; that was a flight far too low for the city of St John. It had a large fleet of large ships! so large, indeed, that it would be impossible for many of them to make their way up the Tay if Parliament sanctioned the construction of the Bridge, which would, in that event, be a standing menace to the maritime importance and general prosperity of the city. Failing in these contentions, its friends, it is said, appealed to the Board of Trade, whose duty it was to report upon the undertaking. That Board, more pliant than the referees, reported against the bridge, and thus did for the Perth Town Council what they were unable to do for themselves.

DEPUTATION TO THE BOARD OF TRADE.

Although for the moment astounded at a result so contrary to the evidence which had been produced, the promoters were nevertheless equal to the occasion. Mr Thornton organised a deputation, consisting of noblemen and Members of Parliament

and a host of local functionaries all interested in the success of the bridge. Bailie Hay, of Dundee, laid the case of the promoters, so far as it related to the navigation of the Tay, before Mr Milner Gibson and the other members of the Board of Trade, and while he spoke with all the prudence characteristic of the profession to which he belongs, there was a power and fervency in his statements which could have been inspired by nothing but an intimate knowledge of the locality combined with an earnest desire to conserve the amenity of the town in behalf of which he appeared. In the course of his address the Bailie proved that the extent of the river traffic between Dundee and Perth had been greatly overstated, and that the tonnage of the vessels engaged in it was much under what the Board had been led to believe. So much was this the case that the speaker had no difficulty in showing that spans considerably less in width and height would be amply sufficient to admit of the passage of such vessels as frequented the port of Perth. The Directors of the North British were not, however, wedded to their deposited plans, and in order to obviate as far as possible the opposition of the Harbour Board of Dundee, to meet the objections of the Board of Trade, and to apply an emollient to the Corporation of the city of Perth, Mr Bouch amended his plan so that the bridge should consist of 25 spans of 120 feet, commencing from the south side; then 18 spans of 200 feet in the centre; and then another 30 spans of 120 feet, which carried the structure to the north shore—in all 73 spans with an aggregate width of 3625 yards, equal to 2 miles 19 poles 1 yard from shore to shore.

APPROVAL OF AMENDED PLANS.

After hearing the deputation and examining the altered plans the Board issued a second or supplementary report superseding their first. They now approved of the Bridge, but suggested that certain details as to the height and width of the spans should be left for consideration and adjustment under the provisions of the Railway Clauses Act, 1863. This report was read to the referees as the examination of witnesses in favour of the undertaking was proceeding. There was no doubt of a favourable result. A severe cross-examination by Sir Thomas Phillips in favour of Perth failed

to invalidate the evidence of Mr Bouch, and supported as he was by engineers of such eminence as Abernethy, Hawksley, and Harrison, the referees only confirmed the general expectation when they reported "that there was no engineering objections to the works as proposed; that such works would be sufficient for the objects intended; and that the estimate for the execution thereof was ample."

AMALGAMATION OF THE CALEDONIAN WITH THE SCOTTISH NORTH-EASTERN.

It was now certain that the Bridge Bill would be carried successfully through all its stages; but however successful in Parliament, its promoters knew that the construction of the Bridge depended upon the reception which might be given to the Bill which was being promoted to sanction the amalgamation of the Caledonian with the Scottish North-Eastern Railway. Against this amalgamation there were no less than twenty-three petitions from Town Councils and other bodies interested in the trade of the district through which the Scottish North-Eastern passed. The burghs appeared by counsel on the 27th April 1866 to support the averments made in their petitions, but the Caledonian Board lodged objections to their *locus standi*. These objections the referees sustained, and in this way a powerful Railway Company thought to "muzzle" the burghs of Dundee, Aberdeen, Montrose, Forfar, Bervie, and Cupar Fife.

ATTEMPT TO MUZZLE THE BURGHS FRUSTRATED.

For the first time in their history the right of the Scotch municipalities to defend the interests common to all was questioned and denied. Energetic measures were therefore adopted to enlighten the referees as to what a Scotch burgh really was. Special meetings of the respective Town Councils were held, and petitions praying that Parliament would protect them in their right to protect themselves adopted. At the same time Mr Clarke, their counsel, was instructed to apply for a re-hearing, which, after a strong and persistent opposition by Mr Mundel on behalf of the Caledonian Directors, was granted. At this re-hearing, which took place on the 7th of May, Mr Denison

appeared for Aberdeen, and Sir Alexander Anderson, Lord Provost of that city; Mr Duncan M'Laren, M.P. for Edinburgh; and Mr Christopher Kerr, Town Clerk of Dundee, gave evidence of such importance as to the powers and duties of Scotch Town Councils that the referees could not do otherwise than reverse their former decision, and the Court was now of opinion "That the Provosts, Magistrates, and Town Councils of the Royal Burghs of Scotland have a *locus standi* in cases where their petitions allege injury to the general interests of the inhabitants." This was a most important victory for the governing bodies of the Royal Burghs of Scotland. If they had submitted to the decision which deprived them of all power to interfere on behalf of the communities they represented, such submission would have formed a precedent quotable against them in future emergencies of a like nature, and trading Companies, Railways especially, would have used their new-found powers without the least consideration for other interests than their own.

THE PREAMBLE OF THE AMALGAMATION BILL PASSED.

Having succeeded in reclaiming a right of which they had been so summarily deprived, the burghs did their best to prevent the contemplated amalgamation. But the Committee of the House of Commons had evidently decided to find the preamble of the Bill proved, in the hope that the amalgamating Companies would be induced to agree to such clauses as would enable the North British to use the Caledonian system, or a part of it at least, in competition with the owners thereof. In this hope the Committee were most certainly disappointed. Clauses generous enough in phraseology were proposed and carried; but these had to be wrung from the Caledonian, and, in view of this circumstance, Mr Hodgson did not believe that powers so conceded could be profitably worked upon the line of a Company the Directors of which had shown themselves so hostile to the North British, of which he was the head. It was therefore not surprising when, on the 20th of July 1866, the Committee of the House of Lords passed the preamble of the Amalgamation Bill that he should seriously contemplate the withdrawal of the Bill for the construction of the Tay Bridge.

COLLAPSE OF THE SECOND ATTEMPT TO OBTAIN POWER TO CONSTRUCT THE BRIDGE.

On Mr Hodgson's intentions becoming known the representatives of the Burghs then in London met on the 23d to consider what steps could be taken to encourage him to proceed. At this meeting there were present:—For Dundee—Provost Parker, Bailie Hay, and Councillors Neave and Allan; for the Dundee Harbour Board —Messrs Yeaman and Norrie; for Forfar—Councillors White and Barry; for Montrose—Bailie Smith; for Cupar Fife—Provost Pagan. Provost Parker occupied the chair, and after consideration the meeting held that it was essential for the interest of the public that the North British should have the same facilities for traffic within the district as the Caledonian; and notwithstanding the passing of the Amalgamation Bill, Mr Hodgson was urged to proceed with the construction of the Tay Bridge as absolutely necessary to meet the demands of increasing trade, while the favour in which the North British was held would be greatly increased by such a commuuity of interests as the construction of the Tay Bridge would ensure. The resolutions of this meeting were transmitted by Provost Parker to Mr Hodgson, but the Provost had to be satisfied with the assurance that Mr Hodgson would lay them before his co-Directors, and, if they resolved on proceeding, he would not oppose them. A meeting of the North British Directors was held on the [26th, and, although the Burgh representatives attended and stated their reasons for proceeding with the Bridge in the clearest and most forcible terms, the Directors could not undertake so costly a work as the bridging of the Tay until they saw if it were possible to work under the provisions of the Amalgamation Bill. Mr Hodgson had other and more cogent reasons, the chief of which was the perilous financial condition of his own Company, and he knew better than any other how such a condition would affect the ambitious schemes and costly complications in which he had involved the shareholders, and which in a few months led to his deposition from the headship of a powerful Railway organisation and the imposition of a more cautious and less ambitious policy upon his successors. Immediately after the meeting with the Burgh representatives the Tay Bridge Bill was

withdrawn. On the following day the Amalgamation Bill passed the House of Lords, and thus the second attempt to obtain authority to bridge the Tay was frustrated, not, as was the first, through the opposition of the local public bodies, but because the tactics of a powerful rival induced a costly Parliamentary struggle, resulting in a successful attempt to absorb a line which, in the hands of the North British, would have been the natural complement of the finished way across the Tay.

THE ESPLANADE.

The reader who has followed us thus far will have seen how intimately the Tay Bridge undertaking was connected with the construction of the Esplanade. In each of the Bills promoted by the North British Railway Directors the right of the town to the solum of the river was conceded. The Esplanade was to be made and finished at the expense of the railway, and then to become the absolute property of the public. To these conditions, as included in the Tay Bridge Bill of 1866, the Department of the Woods and Forests objected. The Town Council, without acknowledging the right of this Department to interfere, agreed to an alteration which gave the inhabitants all the privileges desired, while it reserved the pretended rights of the Crown. These proceedings had their termination in the withdrawal of the Bill, but Bailie Hay did not lose sight of a subject so important as to involve the amenity of the town, the patrimonial rights of the inhabitants, and the jurisdiction of the local authorities over the ground so acquired. Impressed with its importance, he brought the matter before a meeting of the Town Council on the 11th of October 1866, gave a brief history of the dispute with the Woods and Forests, and exposed the duplicity by which the Department had quietly and gradually alienated the property of the public, then flaunted the title-deeds so surreptitiously granted, as precedents in favour of the Crown, in the faces of the rightful owners. By an action brought in 1846, and which the agents of the Crown allowed to be undefended, Lord Ivory had already given judgment in favour of the town, and while this judgment had been suspended to admit of the arrangement of certain details respecting the right of pier possessed by Mr Gray at the Yeaman Shore, it had never been

[illegible] From some cause not very easily explained the action was dropped, and the Woods and Forests, relying upon the [illegible] so clearly manifested, proceeded to make grants of the solum to the Caledonian Railway Company until 12½ acres had been taken without the least intimation to the Town Council of the intention of the Crown to alienate such property. The Council, taking into consideration the fact that ground belonging to them, and guarded in the public interests, had been sold, without their consent, at a cost of from fivepence to eightpence per pole, instructed Town Clerk Kerr to resuscitate the case which was before Lord Ivory in 1846, and for this purpose to summon the Department of the Woods and Forests, the Caledonian Railway Company, the Frontagers interested in the foreshore of the Tay into Court, so that an action which had been in dependence for twenty years might be concluded, and the legal position of all parties in relation to the foreshore defined.

SATISFACTORY ARRANGEMENTS.

The claims of the Town to the foreshore, and of all the parties claiming under the conveyance of the Woods and Forests, were destined, however, to be arranged in another and, all things considered, more satisfactory manner. In November 1866 notices of Bills were given by the Caledonian and North British respectively to sanction the acquisition of part of the solum for station purposes. The Caledonian desired to enclose 15 acres only; but the North British scheduled all the ground which would have been comprised within the Esplanade described in their Bill of the previous session, and extending from the Craig Pier to Buckingham Point; but with power to the Caledonian to take the 15 acres they required. Evidently the Caledonian Directors had not calculated upon the determination of the Town Council to declare and defend their right of property in the solum; but as soon as this determination was made known overtures on behalf of the Railway were made to the Town Council, and on Saturday, the 23d of February 1867, a meeting took place between the representatives of the Caledonian, the Law Committee of the Town Council, and certain representatives of the Harbour Board.

AGREEMENT BETWEEN THE CALEDONIAN RAILWAY AND THE TOWN COUNCIL.

The negotiations commenced at this meeting resulted in two agreements signed at Glasgow on the 26th, by one of which the Magistrates and Town Council agreed, in consideration of a sum of £4000, to sell—(1) That portion of the solum upon which the West Station is built, and conveyed to the Caledonian by the Woods and Forests and others ; (2) that portion of the foreshore lying immediately north of the first, and extending from the Yeaman Shore to the western boundary of the Royal burgh ; (3) fifteen acres lying immediately to the south of the said first portion ; and (4) to abandon all actions and suits, without expenses on either side. By the second agreement, to which the Harbour Trustees were parties, the Caledonian were to be allowed to proceed with their Forfarshire Works Bill without opposition. The Town Council were to obtain during the next session of Parliament power to construct the Esplanade from Craig Pier to Buckingham Point ; and towards the expenses of such construction the Company agreed to pay to the Town Council the sum of £13,700, and to concur with the Magistrates and Town Council in applying to the Crown for a grant to them of the fifteen additional acres required by the Company.

THE NORTH BRITISH RAILWAY AND HARBOUR BOARD COME TO TERMS WITH THE TOWN.

During the progress of these negotiations the North British was approached for the purpose of ascertaining the views of the Directors as to the possibility of a similar agreement being concluded on behalf of that Company, and on the 11th of March such negotiations were brought to a successful termination. The North British was to get possession of all the space lying between the fifteen acres sold to the Caledonian and the north side of the Esplanade at the price of £13,000. The Town Council were to acquire at their own cost the ground necessary to form an approach of at least 100 feet in width from Union Street to the Esplanade, and to fill up the ground required for such Esplanade to a width of 50 feet. On the other hand, the North British undertook to fill

up ground sufficient to make a street 50 feet in width the whole length of, and lying contiguous to, the Esplanade, to flag and pave the half of said street, which street, when finished, was to become the property of the public, and to be subject to the same conditions, control, and supervision as the other streets of the town. On the same day the Harbour Trustees agreed to contribute a like sum of £13,000, simply stipulating that the Esplanade should belong to the public and be finished within five years from the date of their agreement.

THE BOARD OF TRADE CONVEYS THE SOLUM TO THE TOWN.

By this agreement the Board of Trade conveyed to the Town Council all the rights which it was alleged the Crown possessed in the solum for the sum of £250, under the condition that such grant was revokable if legislative sanction for the construction of the Esplanade was not obtained before the end of the Parliamentary session of 1868. It was also stipulated that the Esplanade and contiguous street should belong to the town, and that all the space within them should be used for railway purposes only.

THE DUNDEE SEA WALL, ESPLANADE, AND STREETS ACT.

In November 1867 notice was given of a Bill to confirm and make obligatory the respective agreements already noticed, and to do certain other things necessary to give effect to such agreements. This Bill received the Royal assent in July 1868, and is known under the name of the Dundee Sea Wall, Esplanade, and Streets Act. Under it the inhabitants of Dundee resumed possession of a river frontage extending to nearly a mile in length, and secured a spacious street of 100 feet in width, the one-half of which next the river would be set apart as a public promenade, upon which neither cart nor carriage traffic would be permitted.

AN INTERREGNUM.

The question of the solum and the construction of the Esplanade being at length settled, and in a manner which the most sanguine

of the Town Council of only a few years before could not have anticipated, a considerable obstruction in the path of the promoters of the Tay Bridge was removed. As yet, however, there was not much movement in its favour. The North British Railway had not yet recovered from the shock occasioned by the discovery at the end of 1866 that the Company's exchequer was exhausted. They were still poor, so poor indeed that the Caledonian Directors made their poverty one of their strongest reasons for preventing their acquisition of any portion of the solum—they being, it was alleged, without the means to prepare it for any useful or profitable purpose. In the death of Provost Parker the Bridge scheme had also been deprived of an ardent supporter. In the course of this year (March 1868) Mr James Cox was elected a Director of the North British Railway Company, and on the 2d of December following the electors of the First Ward of the municipality of Dundee sent him to represent them in the Town Council. That body conferred upon him the additional and unexpected honour of a Bailie's chain, and thus enabled him to take part in the management of the Harbour as an *ex officio* member of the Harbour Trust.

THE THIRD PARLIAMENTARY PLAN—1869-70.

The Bridge scheme had still been kept alive both in the North British councils and in the town of Dundee by the energy and exertions of Mr Bouch and Mr Thornton, aided by Mr Adam Johnstone, of Edinburgh, and Provosts Hay and Yeaman of Dundee; and in 1869 plans were carefully matured for the purpose of promoting a Bill in the session of 1869-70 for effecting the desired object. Accordingly Mr Cox was able on the 16th of August 1869 to inform the Harbour Trust that the plans of the Tay Bridge and connecting railways would soon be before the public and them, and bespoke for such plans the favourable consideration of the Trustees. He also indicated that Mr Bouch and the Railway Company designed to throw the Bridge across the river from Tayport to the Harecraigs—the position which was first suggested by this journal in 1863, and favourably considered by the promoters in 1864. It was, however, apparent that such a design would meet with serious opposition. Although

with a Bridge in such a position the engineers had no fears for the Harbour, yet with the Local Authorities it was different; and these could not be made to believe that, with an increasing trade to India, and the size of the ships engaged in such trade, a Bridge of such construction and magnitude in such a position could be aught else than an obstruction to the entrance of the Harbour. This locality was, therefore, wisely abandoned; and when on the 7th of September Mr Bouch, Mr Stirling, and others appeared at a meeting of the Harbour Trustees it was as the exponents of plans upon which was shown the proposed Bridge in nearly the same position as that which was adopted by the Tay Bridge and Union Railway Company of 1865. The line connecting the Bridge with Leuchars had, however, been re-surveyed and laid out so as to minimise the cost of construction, while the station was shown erected on the solum acquired by agreement with the Town Council in 1868, and upon such a level as would connect it with the Bridge by a gradient of 1 in 60, and with the Arbroath section of the Caledonian system by a tunnel crossing under South Union Street and adjoining properties, requiring a considerable curtailment at the north-west corner of Earl Grey Dock, and from thence passing under Dock Street to emerge upon the Arbroath line about the east end of Victoria Dock. The capital required for the completion of this undertaking was estimated at £350,000—exactly the same sum as that set down for the purposes of the proposed Company of 1865. The Harbour Trustees, after hearing the Chairman and the Engineer of the North British, reserved themselves as to details, but resolved to approve of the general features of the undertaking. On the same day the Town Council heard the same explanations as were given to the Harbour Trustees, and thereupon passed a similar resolution; but outside both Boards strong doubts were expressed as to the possibility of carrying the scheme to a successful termination for what was considered the amazingly low estimate of £350,000. It was of no account that engineers of note had attested the estimates of Mr Bouch, and that a contractor was found willing to undertake the work for the sum named. The doubters still shook their heads and were immovable, while active opponents accepted such an estimate simply as a lever to be used by them in their endeavours to overturn and throw back upon the Directors a proposal the

acceptance of which was to be of the greatest advantage to the whole of the North British system. Happily these endeavours were not destined to be successful. The tunnel connecting the East and West Stations was a new feature in the undertaking, which gave considerable satisfaction to the local authorities of Dundee, and banished even the fag-end of suspicion as to any interference with the streets leading to the Harbour.

OPPOSITION WITHIN THE NORTH BRITISH COMPANY.

Opponents were not now to be sought outside, but within the Company itself; and when the Directors recommended the undertaking to the favourable consideration of the half-yearly meeting, held on the 28th of September, Mr Arklay of Ethiebeaton and Mr George Kinloch of Kinloch succeeded in converting a meeting of grave business men into a fiasco. The promoters were not, however, to be overcome in this way. The report, minus the paragraph relating to the Bridge scheme, was put to the meeting and unanimously carried; while Mr Stirling intimated that a special meeting of the Company would be held to consider the whole matter, and to determine as to the course which, under all the circumstances, it would be prudent to pursue. This special meeting was held in Queen Street Hall, Edinburgh, on Friday, the 12th of November 1869. The malcontents, who were chiefly connected with another Company by stronger ties than bound them to the North British, made herculean attempts to influence the opinions of the shareholders of the latter Company. Towards this end a circular containing an elaborate yet one-sided statement against proceeding with the Bridge was sent by Mr Jeffrey, a writer in Glasgow, to every shareholder likely to attend the meeting or grant a mandate. Yet notwithstanding this brilliant display of mental force and cunningly-devised argument Mr Stirling had no difficulty in disposing of objections so speciously made; and although Mr Arklay, Mr Kinloch, and others did their best to prove that the undertaking could not be completed for the estimated sum of £350,000, and, if entered upon, would certainly prove disastrous to the interests of the North British Railway, the meeting by a large majority decided in favour of the Directors, and the

Parliamentary notice of their intention to apply for powers to construct the Tay Bridge and its connecting lines appeared in the same issue of the *Dundee Advertiser* which contained the account of the decisive defeat of the opposition.

PROVOST YEAMAN'S CIRCULAR.

The faith of the people of Dundee was not, however, so fully assured as to allow the Directors to neglect such precautions as were deemed necessary to confirm the favourable impression which had evidently been made. Proposed terms for launching the scheme through a separate undertaking almost akin to the Company of 1865 were adjusted; and on the 22d of November —ten days after the special meeting of shareholders had so unequivocally decided in its favour—Provost Yeaman, as in place of Provost Parker, the old Chairman, issued a circular appealing to the judgment and public spirit of those whom he addressed. This circular enclosed a memorandum of terms which had been sent to him by instructions from Mr Stirling, and which, he was sure, would recommend the new stock "not only to those who, like the people of Dundee, and of the counties of Fife and Forfar in general, are so deeply interested in the bridging of the Tay, but also to capitalists and others desirous of safe investments." According to this memorandum the Bridge undertaking was to be free from all the debts and liabilities of the North British Railway Company. It was to be managed by a body of Directors, constituted one-half of subscribers to the stock and the other half of North British Directors. The shares were to bear a dividend of 5¼ per cent. per annum, and such dividend was secured by a preferable lien over the gross receipts of the railway—the Tay Bridge and its connecting lines—and the North British came under an obligation to convey traffic of all descriptions to and from Dundee, and to and from all places in the north and east of Scotland *via* the Tay Bridge Railway, sufficient to yield to the separate undertakings at least £10,000 in each half-year. The Company also bound themselves to pay all the preliminary charges and all the expenses of the Bill—depending wholly for repayment upon such balance of capital as remained after the completion of the works, while the entire cost of working and maintaining the bridge and its connecting lines was to be borne by them.

PUBLIC MEETING IN FAVOUR OF THE SCHEME.

The public meeting convened by Provost Yeaman assembled in the Town Hall on the 25th—three days after the issue of the circular and memorandum. The Provost occupied the chair, and there were present on the part of the North British Railway Company John Stirling, Esq., Chairman of the Company; W. P. Adam, Esq., of Blair Adam, M.P.; James Cox, Esq.; George Harrison, Esq.; and William Muir, Esq., together with Mr Mason, the General Manager, and Messrs Pattullo & Thornton, solicitors for the Company. The Town Hall was crowded by gentlemen of influence from the town and district, while the Provost and Mr Stirling placed the whole subject so frankly and fully before the meeting that there was no longer any room for doubt as to the sincerity of the North British, or the sufficiency of the estimate to complete the undertaking. The meeting therefore unanimously adopted a motion, moved by the Provost and seconded by Councillor Moncur, "That a Committee be formed to carry out the objects of the Bridge undertaking as explained in the memorandum issued by Provost Yeaman, and also to obtain any amendment thereon that may be considered judicious, and calculated to secure the object in view." The Committee appointed under this resolution met immediately after the meeting, and next day an amended memorandum was issued whereby the North British Directors agreed to recommend to their shareholders to pay interest at the rate of 5½ per cent. out of the receipts of the line upon any excess of outlay over and above the £350,000 named in the estimate, and the share list, which was issued shortly after, contained this condition as an assurance to the public that the North British had no fears of the result.

MR PATRICK MATHEW'S PREDICTIONS.

The Town Council, most of the public bodies, and the inhabitants of Dundee being now convinced of the practicability of bridging the Tay between Wormit on the south and Buckingham Point on the north, and that the completion of such an undertaking was simply a question of time and money, it might have been

expected that no other voice would be raised in opposition and no further unfavourable criticism offered. But no. During the six years the scheme of Mr Bouch had been under discussion the Seer of Gourdie Hill had been so absorbed in his incantations to the powers of Nature that he failed to comprehend the change which public opinion had undergone regarding it, or to mark the progress which had been made towards its realisation. But when the resolution to proceed caught his eye the fairy curtain which obscured the face of his magic mirror is drawn up like the mist from the brow of a mountain, and he beheld the Bridge completed. It is a high, slender, rainbow-like structure, having a barrier of strong palisades on either side to protect it from the fury of the waves and the destroying breath proceeding from the "storm throat" of the Tay. The piers of the Bridge and its protecting palisades have the effect of increasing the velocity of the currents, and these in their turn are scooping out deep channels which threaten to destroy the foundations, while the mud and sand disturbed in the process are forming enormous banks, which will eventually obstruct the entrance to the Harbour, and perhaps endanger the fairway at the mouth of the river itself. But there is still another danger. He sees a ship which has slipped its anchors during a storm. It is drifting up the river, manned by a drunken crew, who, regardless of the consequences, allow it to run against a pier, and, strange to say, the ship is uninjured by the shock, while the Bridge is toppled over like a child's house of cards. Yet a little while and a train filled with happy people is swiftly proceeding along the tortuous structure. Its weight and velocity acts with such a centrifugal force upon the curve that the workmanship is unable to bear the strain, and he sees the Bridge open up, and the train, with its human freight, precipitated into the river a hundred feet below. An islet is now seen in the firth where no islet existed before, and its component parts are loose stones, fragments of iron and of wood, together with mangled human bodies, and the eels are gliding out and in between the interstices of the horrible scene. The Bridge itself is a wreck, and never more will be used as a medium of communication between the counties of Fife and Forfar. And yet once more. A giant, restless in his sleep, is seen struggling under the district of Comrie. At every turn the monster makes the earth is shaken

as if subjected to an attack of palsy, and the radius within which these shakings and tremblings are felt includes the Carse of Gowrie and—Dundee ! A shake which scarcely moves the tallest and most slender chimney in the smoke-begrimed town has ample power to throw the rainbow bridge into the Tay, and all the powers which man can exercise can hardly set it up again. Thus the Seer predicted the fate of the great undertaking in a series of eight letters written to the *Dundee Advertiser*, beginning on the 7th of December 1869 and ending on the 11th of March 1870. Through whatever medium the Bridge might be viewed, Mr Mathew saw nothing but disaster, and it is a question had he lived to witness the heavy ballast trains which have daily crossed the Tay by its iron roadway whether he would not have found some other agent as a substitute for that centrifugal force which has so treacherously failed to aid him in the fulfilment of his predictions.

THE EARTHQUAKE IDEA RIDICULED.

Commenting on these extraordinary efforts to frighten the public at the prospect of erecting a bridge at any point nearer the mouth of the river than Mugdrum, the *Dundee Advertiser* said :— "Having exhausted all other causes of alarm, Mr Mathew in one grand final effort invokes an earthquake to do the business ! There are earthquakes, he tells us, at Comrie, and dry earthquake waves in the lower regions of the Mississippi, and the inference is that there may be earthquakes in Dundee. Mr Mathew himself attests that he has felt several in the Carse of Gowrie. Well, we rather congratulate him on his experience. They do not appear to have done him much harm. A more healthy, vigorous octogenarian is not often seen than our worthy correspondent, and if he is a specimen of how much we are likely to suffer from earthquakes we should not object to feel a few of them ourselves. He does not appear to have dreaded the overthrow of the house of Gourdiehill. The Church of Errol stands erect, notwithstanding the subterranean commotions of the Carse, and we have not heard that the Old Steeple of Dundee has given any signs of falling into unsteady habits. The Law and Balgay Hill have neither danced, nor skipped, nor reeled. We wish, indeed, that the next time Mr Mathew feels one of the earthquakes which visit the Carse he

would seize hold of it, and detain it until we send out a reporter to "interview" it and question it, and take its likeness, and get to know where it came from, and where it is going, and what it has done and intends to do. . . . . To speak seriously, however, the promoters of the Tay Bridge are not likely to be affrighted by such imaginary dangers as those from lightning and earthquakes. The legitimate arguments in favour of what Mr Mathew desires—the bridging of the Tay at Newburgh—are only weakened by magnifying improbabilities into real dangers. It is just as likely that an earthquake will swallow up Gourdiehill as overthrow the Tay Bridge."

FURTHER EFFORTS TO SECURE PUBLIC CONFIDENCE IN THE UNDERTAKING.

On the 8th of December 1869 the *Advertiser*, which through good and bad report had advocated the scheme, and encouraged the promoters in their deepest depression, made a proposal that the Corporations of Dundee and the other burghs of Forfarshire should take up a portion of the stock of the Bridge—a proposal which these bodies were in no hurry to consider; and on the 31st of the same month Bailie Cox exhibited within the reading-room of the Royal Exchange a large perspective sketch of one of the longest spans, and nothing better could have been done to enable the public clearly to understand the design, the strength, and magnitude of the noble structure. Parties interested in the propagation of unfavourable reports were still, however, busy with their machinations, and the Directors of the North British were under the necessity of issuing, on the 1st of January 1870, another circular reminding their shareholders of all which had already been done; that the annual cost (£18,375) of the sum required to finish the Bridge and its connecting railways would be, by the time of its completion, some thousands of pounds less than the expense (£12,600) of working the Ferry at Tayport, and the sum (£12,300) which would fall to be paid in tolls to the Caledonian. They also intimated that one of their number, Bailie Cox, had headed the list of subscribers with £10,000, while the Engineer attested his confidence in his own work by subscribing a sum of equal amount, and they now appealed to the general body of their

shareholders for a hearty co-operation in carrying the scheme to a successful issue. At the same time, while quite satisfied of the fidelity and ability with which Mr Bouch had made his calculations, they sent, through him, to Mr T. H. Harrison the whole of the details, and this eminent engineer bore strong testimony to the care which had been taken to make the Bridge in every part of such a strength as to banish every suspicion of insecurity; and Mr John Heppel, a mathematician of great repute, who, at Mr Harrison's request, had made an independent examination of all the engineering points which had been referred to him, reported his "complete conviction of the sufficiency of the design in every particular, whether in regard to the foundations, the piers, or the superstructure." On the 7th of the same month the Property Committee of the Town Council of Dundee reported certain alterations required to be made on the Bill in the interest of the town, and to which the Company were willing to give a favourable consideration, but the Town Council itself, while professing to be friendly, refused to subscribe to the capital of the undertaking, and, so far as our information extends, the Harbour Trustees never entertained the proposal. Notwithstanding these discouragements, combined with the general apathy of the wealthy citizens of Dundee, Bailie Cox was able, at a meeting of the Town Council held on the 27th of January, to make the agreeable intimation that nearly one half of the stock had been taken up.

NORTH BRITISH SHAREHOLDERS ENDORSE THE PROCEEDINGS OF THE DIRECTORS.

As the time, however, for prosecuting the Bill before Parliament approached, and as the Directors of the North British had given at least an implied promise that no Parliamentary proceedings would be taken until the whole capital was subscribed, it became necessary to convene a special general meeting of the shareholders to determine whether, under the circumstances, it would be prudent to proceed. This meeting was held in Queen Street Hall, Edinburgh, on Thursday, the 10th of February. Mr Kinloch was not present, but Mr Arklay, as usual, was at his post to protest against the extravagance of the Directors in spending so much money upon a scheme so questionable, while the poverty of the Company was so

conspicuous; and to move that the sanction of the shareholders to enable the Directors to appear in Parliament in connection with the Tay Bridge undertaking be withheld. The few supporters who still followed him showed no signs of the activity or vigour which distinguished them at former meetings, and it was evident that the few half-hearted attempts at opposition were only meant as feints, to cover the defeat which they saw was impending. In such circumstances the Chairman's confidence was not misplaced, and his motion to proceed was carried by a large majority of those present at the meeting, while he had proxies in his favour representing nearly two millions and a half of stock.

HARBOUR OBSTRUCTIVES.

Being thus in possession of the full confidence of the shareholders, the Directors of the North British Railway Company might have justly looked forward to a Parliamentary campaign unimpeded by local interests; but the Harbour Board had recently received a new constitution, and many of the new members were disposed to lie upon their oars, if not, indeed, intent upon pursuing a policy of retrogression. It was so, at least, in the case of the Tay Bridge. Although their immediate predecessors had recorded an entire approval of the undertaking, that was not to be an obligation upon them, their successors in office. Accordingly a meeting to consider the matter was held on the 16th of February, at which there were present from the Directors of the North British Railway Mr Stirling, the Chairman; Mr George Harrison, of Edinburgh; and Mr William Muir, of Leith. These were accompanied by Mr Bouch, the Engineer, and Mr Johnstone, the solicitor for the Company; while Bailie Cox attended in his place as a member of the Trust. After a long examination of Mr Stirling and Mr Bouch, the leaders of the opposition—whose interests in the Harbour seemed to be more personal than public—proclaimed their dissatisfaction with the position of the proposed tunnel, and expressed a desire that no proceedings should be taken respecting it until the following year. Mr Bouch explained that such a proceeding was tantamount to killing the Bill, and would, if sanctioned, destroy the security held by the North British for the

traffic of the North of Scotland through Dundee, inasmuch as the power to run their trains over the Dundee and Arbroath section of the Caledonian system would cease before another Bill could be brought before Parliament. These conservators of the Harbour could not, however, be satisfied ; and on Dean of Guild Maonaughtan moving the approval of the Tay Bridge scheme in its entirety, Mr Cutlar met it with the amendment—"That this Board, while approving of the Tay Bridge, are opposed to all and any interference with the docks and accesses thereto, and resolve to petition against the Bill." The Dean was ably seconded by Bailie Buchan ; while Mr Mudie, in seconding Mr Cutlar, "was sure that if the Chamber of Commerce and other public bodies had been aware of all the facts there would have been such a cry out against the scheme as would have made the Trustees recede from their position." The Dean's motion to approve of the whole undertaking was, however, supported by Mr P. H. Thoms and other old and experienced Trustees, and carried by a majority of 15 to 14—Mr Cutlar causing some confusion by an ungracious attempt to prevent Bailie Cox from recording his vote. Doubtless the opponents of the Bill would not have objected to the Bailie's presence as one of the deputation from the Directors. In such a position he could not have voted as a Trustee of the Harbour; but, after all, the change of character would have been of little avail, as the casting vote of the Chairman would have decided the matter against them. The Harbour Trustees having thus narrowly escaped the position of petitioners against the undertaking, there only remained to be dealt with the Caledonian Railway Company and the Lord Provost, Magistrates, and the Town Council of the city of Perth. These deposited elaborate petitions against the Bill. That by the Caledonian was of course deposited for strategical purposes ; but the authorities of Perth founded theirs upon a chimera, for they had now no shipping for the convenience of which it was desirable to preserve a better water way up the Tay than that which the proposed Bridge would give, and before entering the Committee-room an arrangement was effected under which the North British Railway Company, with the consent of the Board of Trade, would be allowed to reduce the height of the bridge from 100 to 80 feet above the level of high water, and in return for this concession the Tay Navigation Commissioners, who, it appears, are identical

with the municipal authorities of Perth, were to receive an annual sum to enable them to keep a small steamer for the purpose of towing such vessels up the river as were destined for ports above the Bridge.

THE DUNDEE CHAMBER OF COMMERCE AND THE BILL.

On the 15th of March 1870 the members of the Chamber of Commerce were convened to consider the terms of the Bill. At this meeting Mr Duncan Sidey, the President of the Chamber of Commerce, presided. The resolution in favour of the undertaking was moved by Mr John Don, and seconded by Mr O. G. Miller, while the petition in favour of the Bill was moved by Mr Thomas Smith, and seconded by Mr Alexander D. Grimond, who, as already seen, had, along with his brother Mr Joseph Grimond, supported the scheme from its origin. In spite of the assurance which Mr Mudie gave the Harbour Trustees on the 16th of February, the Chamber was all but unanimous—Mr Peter Kerr being the only dissentient. Mr Kerr was inclined to think that too much had been made of the Tay Bridge. The idea of erecting such a structure within the precincts of the Harbour was most preposterous. Our noble river would be disfigured and rendered useless. There was evidently personal consideration at work. The late divisions at the Harbour Board was a proof of what he said—the bare majority of one having been brought about by the vote of the most active Director (Bailie Cox) of the North British Railway in connection with the scheme in Dundee; and had the division been otherwise, we would have heard no more of the Tay Bridge. Yet the scheme contained all the elements of success. It was its magnitude only which frightened people like Mr Kerr. Mr Mathew did not live to see what he considered the evil-omened structure completed, but Mr Kerr has; and it would be interesting to know if he still adheres to the opinions of which we have given an outline, when he of all the Chamber stood a protester against the otherwise unanimous vote which was then given.

SUCCESS ASSURED.

On the 17th of March the Select Committee of the House of Commons met to hear evidence on the Bill. There was now no end

of support to it. Among the witnesses examined in its favour were the Earls of Airlie, Camperdown, and Strathmore, and Sir John Ogilvy—all of whom, to their honour, had from the very outset aided the local promoters whenever required; Sir Robert Anstruther; Provost Yeaman, Dundee; Provost Whyte, Forfar; Provost Mitchell, Montrose; Mr David Corsar, Arbroath; Bailie Buchan and Mr O. G. Miller, Dundee; Mr John Jeffrey, Kirkcaldy; Mr John Walker, Secretary to the Company; Mr Samuel L. Mason General Manager; Mr P. M'Pherson, Goods Manager; Mr John Geddes; Mr Bouch, C.E.; Mr T. H. Harrison, C.E. On the 21st the Committee found the preamble of the Bill proved so far as it related to the Tay Bridge and its connecting lines; but the joint-proprietorship which the North British held in the Dundee and Arbroath Railway was to cease on the expiry of the powers conferred on the North British Railway Company by the Amalgamation Act of 1866. This was at once a great victory and a serious loss—a victory because the construction of the Bridge was now assured, and a loss because it made Dundee the terminus of the East Coast Line, and would for a considerable time prevent the North British Directors from pushing beyond Dundee to Montrose and Aberdeen. On the 31st the half-yearly meeting of the North British Company almost unanimously authorised the Directors to subscribe £100,000 to the capital of the undertaking, while the discussion and arrangement of clauses occupied the opposing parties from the 23d of March until the 1st of April, on which day the Bill passed through Committee.

A PLEA FOR A DOUBLE LINE OF RAILS.

On the 5th of April the *Advertiser* renewed its appeal for a bridge of sufficient width to admit of a double line of rails, and the reasons for such are set forth in the following extract:—"We are such believers in the success of the bridge that we think it will be a big blunder to make it for only a single line of rails. Just consider what its promoters intend this Bridge to be. It is to be the great highway between Dundee, Arbroath, Forfar, Montrose, Aberdeen—indeed, all the north-east of Scotland—and the south. It is to be part of the great East Coast Route, just as are the bridges at Berwick and Newcastle, and will only differ from them

in being from eight to twelve times longer than they are. It is the beginning of the through line between Dundee and Edinburgh, and all the most important through trains to and from the south will go and come by it. Then it is to be the great feeder of Dundee for coals, iron, stone, and lime, and enormous trains of these materials are expected to come by it. But besides a multitude of through passenger trains and of heavy goods trains, it is calculated that there will, before many years pass away, be as many local trains as there are now between Dundee and Broughty Ferry. . . If this Bridge is properly constructed, there will be new suburbs of Dundee on the St Fort, Naughton, Birkhill, and Wormit estates, on the south side of the Tay, far more salubrious, attractive, and popular than Broughty Ferry. New villages and towns will spring up in the north of Fife with a rapidity only paralleled by what has already occurred on the Clyde, the Mersey, and the Thames. But how can these expectations be fulfilled if there is to be only a single line of rails for two miles across the Tay? . . True sagacity looks not only to present but prospective needs. This bridge, if built at all, should be built to serve all possible requirements for a century to come ; and if this is done we are satisfied that it will be made for a double and not a single line of rails. Now that a reduction is to be made in its height, an addition should be made to its width. We are so satisfied of the expediency of this being done that we do not wish the Tay Bridge Bill to pass through its remaining stages without this question being fully considered ; and we thus early and emphatically state our views respecting it." There is no doubt this plea was very carefully considered at the time, but that it did not influence the proceedings of the promoters the finished structure with which we are now familiar shows. There is as little doubt that the Directors of the North British Railway would willingly have made the Bridge to carry a double line of rails, but the tardiness with which the stock was taken up made it incumbent upon them to provide for nearly a third of the capital required. They were therefore, per force, obliged to content themselves with the Bridge as proposed, and to rely upon its success as a single line to induce the public to provide additional capital, and thus enable them to double the means of transit across the Tay. A few years, perhaps a few months, may demonstrate the necessity of enlarged

facilities to accommodate the increase of traffic, and the prospect of a broader and more efficient Bridge may not be so distant as many imagine.

BILL RECEIVES THE ROYAL ASSENT.

The Bill came before a Committee of the House of Lords on the 28th of June 1870, and petitions were deposited in its favour on behalf of the Dundee Chamber of Commerce; the Guildry Incorporation of Dundee; and the Magistrates of the Royal Burghs of Dundee, Arbroath, Montrose, Forfar, and Brechin. The Caledonian Railway Company, and the debenture and preference shareholders of the North British itself, were the chief opponents. All the disputed questions were, however, arranged, and the Bill passed the Committee on the 1st of July, and was introduced to the House of Lords as unopposed. Two weeks thereafter it received the Royal assent, and application was immediately made to the Board of Trade for leave to reduce the height of the bridge from 100 to 80 feet. With the Board of Trade the promoters had no difficulty. The reduction of the height by 20 feet while making the gradients easier gave a more graceful appearance to the unique structure; and the yearly pension of £600 received by the Tay Navigation Commissioners has converted their self-predicted evils into present and prospective blessings.

THE FIRST DIRECTORATE UNDER THE NEW ARRANGEMENTS.

It has already been said that the Directorate of the Tay Bridge undertaking under the agreement of 1869 was to consist of six members—one half to be chosen from the Directors of the North British Railway Company, and one half from the subscribers. From the Directors there were chosen—James Cox, Esq. of Clement Park, Lochee, to be Chairman of the undertaking; John Stirling, Esq. of Kippendavie; and Wm. Muir, Esq., Leith. And the representatives of the subscribers were selected from the three chief towns of Scotland, viz.:—G. W. Clark, Esq., Glasgow; James Falshaw, Esq., Edinburgh; and James Yeaman, Esq., Dundee.

DESCRIPTION OF THE BRIDGE, RAILWAY, STATIONS, TUNNEL, &c.

CONTRACT ENTERED INTO.

The Act of Parliament for the construction of the Bridge having been obtained in 1870, and other preliminaries arranged, the first step was the selection of a contractor to carry out the work—an appointment which necessarily required to be made with great circumspection, for the project on hand was one of no ordinary magnitude. It was the erection of a railway bridge over the widest tidal river that had ever been spanned—a river with a deep rapid current, and subject at all seasons to violent gales, which sweep down the estuary as through a funnel, with the concentrated force of a tempest. On all hands the difficulties were admitted to be very great, while not a few regarded them as perfectly insurmountable, boldly asserting that in the trial of strength it would be found that engineering skill was unable to cope with the forces of Nature. But the construction of the high level pontage, in itself to be regarded as a signal triumph of science, was an undertaking of paramount importance to the North British Railway Company, not only because it would more effectually open up the collieries of Fife and shorten the distance between Edinburgh and the North, besides saving the cost of the ferry and the tollage (about £13,000 per annum) paid to the Caledonian Railway Company for working the traffic between Broughty Pier and Dundee, but more particularly because its erection was the initial step towards the far greater object in view—the bridging of the Forth; and accordingly the scheme was entered upon with that resolute determination which was the best omen of success. The number of contractors who were able to offer for a work of this magnitude was, of course, limited, and it was natural that they should be somewhat chary in estimating for the construction of the Bridge, seeing that the contingencies were such as to render precise calculations impossible. As the result of the negotiations,

Messrs Charles De Bergue & Co., of London, Cardiff, and Manchester, were accepted as the contractors. On the 8th May 1871 the North British Railway Company entered into an agreement with that firm for the execution of the work, the contract price being £217,000, and the time specified for the completion of the Bridge three years. That period has been doubled, for it has taken six years to complete the work, while the total cost has been increased to about £350,000; but it ought to be mentioned that the promoters, in fixing such a limited period as three years, proceeded on data which subsequently proved inaccurate in several essential particulars, and it would also seem that a sufficient margin was not allowed for the elemental forces to be encountered during the progress of the work.

TRANSFER OF THE CONTRACT.

There is no doubt, however, that the illness of Mr Charles De Bergue, the principal partner of the contracting firm, and the complications which arose after his death, resulting in the transference of the contract to Messrs Hopkins, Gilkes, & Co., of Middlesborough, were the chief causes of the delay. Mr De Bergue had had extensive experience in bridge building in this country and also on the Continent, and but for the fact that shortly after the signing of the contract he was struck down by illness, which subsequently proved fatal, there is every probability that the Bridge Railway would have been opened for traffic a considerable time ago. The time and money cannot be said to have been spent in vain, however, as the experience which has been gained in constructing the Tay Bridge will prove of incalculable advantage in carrying out other undertakings of a similar kind.

THE ENGINEERS.

To Mr Thomas Bouch, the North British Railway Company's eminent Engineer, is due the honour of planning the Tay Bridge; and for the successful accomplishment of the work not a little of the credit deserves to be awarded to Mr William Paterson, the Railway Company's Resident Engineer, and to Mr Albert Grothe and Mr Austin, managers for the contractors, with their able coadjutors Mr Reeves, Mr Camphuis, and others.

LENGTH OF SPANS.

Before proceeding to narrate the process of its construction, a brief general description of the bridge and its site will enable our readers to understand the details more easily. The new Tay Bridge Railway strikes off from the present main line near Leuchars, and reaches the south side of the Tay at Wormit, about two miles above Newport, from which point the railway is carried over the Tay on the Bridge to Magdalen Point at the west end of Dundee, where it joins the line formed on the Esplanade ground, connecting it with the new underground station at South Union Street. Starting from the south end, the Bridge crosses the river almost due north and south for about three-fourths of the distance, when it makes a curve, having a radius of twenty chains, to join the land line, which runs at right angles. The Bridge, which carries a single line of rails, is 3450 yards in length, and consists of 85 spans of the following dimensions :—

11	spans of	245	feet each,	lattice girders.
2	,,	227	,,	,,
1	,,	166	,,	bowstring girders.
1	,,	162·10	,,	lattice girders.
13	,,	145	,,	,,
10	,,	129·3	,,	,,
11	,,	129	,,	,,
2	,,	87	,,	,,
24	,,	67·6	,,	,,
3	,,	67	,,	,,
1	,,	66·8	,,	,,
6	,,	28·11	,,	,,

CONSTRUCTION OF THE PIERS.

In the case of the two spans of 227 feet and the eleven spans of 245 feet, and in the bowstring span, the roadway is carried on the bottom booms of the girders, while in the other spans it is laid along the tops of the girders, this arrangement in the case of the wide spans in the centre of the river allowing a clear waterway of 88 feet for the passage of vessels to and from Newburgh and Perth. The piers are of varied construction, but in most cases the foundations are formed of iron cylinders filled in with brick

and concrete. Piers 1 to 14 are entirely of brick in cement. Piers 15 to 48 are brick for 5 feet above high-water mark, finished with a stone belting, upon which are carried groups of cast-iron columns braced together. Piers 49 to 77 consist of groups of cast-iron columns braced together, starting from the cylinders and encased in brickwork to a height of 5 feet above high-water mark. Piers 78 and 79 are cast-iron cylinders throughout, filled with concrete. Piers 80 to 84 are cast-iron columns. In form the bridge is slightly arched, the greatest height from the rails to high-water level being 88 feet at the centre of the large spans. The end of the land line at Wormit is almost 70 feet above the level of high water, the selection of ground of this altitude for the beginning of the Bridge enabling the engineer to give the requisite height in the centre of the river with the comparatively easy gradient of 1 foot in 365. On the north side, however, where the land is low, and the line requires to be brought down towards the level of the underground station, the slope is much more considerable—about 1 foot in 74.

BASE OF OPERATIONS.

In constructing the Bridge the contractors selected the south end as their principal base of operations. At this point a series of trap rocks rises almost precipitously from high-water line to a height of fully fifty feet, and the very limited extent of beach at their disposal rendered it absolutely necessary that the contractors should acquire additional ground for the erection of workshops, foundries, offices, and dwellings for the workmen. This was the occasion of some delay at the outset of their proceedings, as the late Mr Wedderburn of Birkhill objected to any part of his land being acquired for such uses, and applied to the Court of Session to interdict the contractors from erecting the contemplated buildings on his property. Lord Mackenzie, before whom the case was debated in the Outer House, refused to grant the petition, and on appeal the First Division confirmed the Lord Ordinary's interlocutor. The contractors were therefore successful in obtaining the additional ground required, and the erection of workshops, offices, cement and other stores, and a range of buildings for the workmen was immediately begun, while the construction of the

land abutment—a heavy piece of masonry forming the termination of the land line and the commencement of the Bridge—was at the same time carried on with energy.

THE FOUNDATION-STONE.

By the middle of July the erection of this land abutment was so far advanced that the formal ceremony of laying the foundation-stone was fixed to take place on Saturday, the 22d of that month. The beginning of any great undertaking is generally attended with some interesting proceedings, but the ceremonial of that eventful Saturday was not invested with the customary *eclat*, the contractors acting on the principle that deeds, not words, best became them at the outset of an undertaking regarding the successful completion of which there existed no little dubiety in the public mind. Comparatively few spectators were present when Master Paterson, son of the resident engineer, lowered the foundation-stone to its bed; but the cheers were none the less hearty when the youthful mason, giving the stone the orthodox three knocks, announced that it had been properly laid. A flag was immediately hoisted in honour of the auspicious event, and the cheers of the spectators were lustily re-echoed by the workmen. Sheriff Monro, of Kinross and Clackmannan, who was the spokesman on the occasion, proposed "Success to the Tay Bridge Undertaking" in a few appropriate words; and the hope he expressed that the spanning of the Tay would be the prelude to the much greater achievement of bridging the Forth seems now about to be realised.

WORKSHOPS AND OFFICES.

After this formal inauguration the work proceeded apace. A wharf was run out a distance of eighty yards to facilitate the landing of material; and workshops, cement stores, engineers' offices, and houses for the workmen were subsequently erected. In connection with the accommodation provided for the workmen, it deserves to be mentioned with commendation that from the very outset a special interest was manifested in the employees, for whose comfort and welfare the utmost anxiety was shown. One of the first buildings to be opened on the suggestion of Mr Grothe was the Tay Bridge Co-operative Association, including a dining-hall,

reading-room, kitchen, dormitories, and other accommodation; and the arrangements were made on such a liberal scale that the men were enabled to procure the best victuals at little more than cost price. At first only 70 men were employed, but as the work extended and the various departments became thoroughly organised, additional hands were engaged, the number soon amounting to 250. With this large staff the progress of the work soon became manifest.

THE BRICK PIERS.

By the middle of September the land abutment was completed, and a most substantial piece of masonry it is, the blocks employed being obtained from the famous quarries at Carmylie. During the same month the first two piers were finished and the third in progress, comparatively little trouble having been experienced in building them, as the first was quite close to the cliff and the foundations of the second and third were exposed at low water. These piers, of rectangular form, were built wholly of brick, set in Portland cement—a substance which a little exposure solidifies like stone, so that the piers are practically huge monoliths. Of course, the chief difficulties the contractors had to deal with were connected with the formation of the piers under water. In previous years the only plan of constructing such piers was by forming a cofferdam, and then pumping out the water and building from the foundation; and had no other mode than this been available, it is improbable that any attempt would have been made to bridge the Tay, as the expense, no less than the time occupied, must necessarily have been great. Engineering science, however, has made rapid advances in recent years, and great improvements have been introduced in pier building.

FLOATING OUT AND PLACING OF THE PIERS.

One of the first principles laid down by the engineers at the Tay Bridge, and which was consistently followed throughout, was to build the piers and girders on shore and float them out to their destinations, so as to dispense with heavy staging and scaffolding. For this purpose a portion of the beach was levelled and laid with a floor of concrete, and here all the piers and girders were built

previous to being floated out to the respective sites they were to occupy. In the construction of the first few piers under water the work was necessarily of a somewhat tentative character, the experience gained in their formation leading to the introduction of several important improvements, the adoption of which greatly facilitated the future progress of the work. The plan first adopted was to build and sink separately the two cylinders composing each pier. Each cylinder, of wrought iron, was, in the first place, erected on the concrete floor, and filled in with a lining of brickwork up to the level of low water, leaving an opening in the centre. When finished to this extent the cylinder was floated out by means of two pontoons and sunk to its position. A cylinder of this description weighed about 40 tons, but when contrasted with the large piers which were subsequently floated out it came to be regarded as a mere toy. Having been sunk to its proper position, the water was forced out of the cylinder by air compression. Workmen then descended the shaft, and as they excavated the soil the pillar settled down by its own weight until the rock was reached, generally at depths of from eight to fifteen feet. The foundation was then properly adjusted, and the base and shaft filled up with concrete, so that the pier up to the level of low water formed one solid mass of brickwork and concrete permanently cased in iron. The temporary caissons above low water level were then removed, and the brickwork carried upwards to the necessary height. The first six water-piers were built on this separate principle ; but from the narrowness of the base of the cylinders —9½ feet—much trouble was frequently experienced in sinking them owing to the presence of numerous large boulders. It often happened that one side of the cylinder would be resting on a huge boulder, while the other was sinking through the quicksand. In consequence of this unequal settlement, the pillars would list over to this or that side, and in three instances the strong current and tempestuous sea caused them to topple fairly over—mishaps which led the engineers to discontinue the practice of sinking the pillars separately.

CHANGE OF SYSTEM IN SINKING THE PIERS.

To overcome the difficulty it was resolved to construct each pier not of two separate pillars, but as a complete structure, consisting

of two engaged cylindrical pillars, rising from a common base, having long straight sides and circular ends. No. 10 pier was the first one built on this combined principle, and the adoption of this improved process was attended with most satisfactory results. For the construction of one of these combined piers there was provided, first of all, a wrought-iron base 3 feet high, 22½ feet long, and 10½ feet wide, with flat sides and circular ends, which was laid on the temporary concrete floor formed for the purpose on a part of the beach left dry at low water. This base was surmounted by a conical cast-iron five feet length, furnished with a top flange 2½ feet wide, the base and sur-base constituting a hollow chamber 8 feet high, sufficiently large for two gangs of six men each to work in. On the broad flange of the sur-base brickwork was carried up to the level of low water in two circular towers 9½ feet in diameter, surrounded by cast-iron cylinders of ¾-inch metal in four segments, a shaft four feet in diameter being left in each tower for the descent of the workmen to the chamber at the bottom. To transport this unwieldy mass of brickwork—about 140 tons in weight—from its temporary resting-place on the shore to its permanent position in the bed of the river a simple but most effectual arrangement was introduced by Mr Austin.

HYDRAULIC APPLIANCES.

Two pontoons, each bearing two strong, malleable iron girders, besides hydraulic rams capable of lifting 60 tons apiece, were floated so as to bring the pier into the centre between the girders. The latter were connected by wrought-iron links with the base of the pier, which was provided with vertical suspending bars. To these were connected a pair of balancing crosshead plates by a central bolt, the hydraulic rams being similarly provided with crosshead plates, while the upper and lower sets were attached to the wrought iron links. The hydraulic rams had a stroke of 12 inches, and the links, which passed through slotted holes in their bases, were perforated with holes 12 inches apart corresponding to the stroke of the ram. Being fixed to the pier at low water, the girders gradually lifted it as the rising tide raised the pontoons, and the whole mass was subsequently towed out at high water from its temporary resting-place to the permanent position it

was designed to occupy, the weight of the pier, which was submerged to the extent of eight feet, being carried on steel pins passed through the holes in the links and resting on bearings provided on the bases of the rams. When the pontoons had been securely anchored, with the pier in suspension, the lowering process was at once begun. To lower the pier, the crossheads on the rams were connected by pins with the links at the top of the stroke. Then the hydraulic force-pump—of which there was one on each pontoon—with a few strokes raised the pier about an eighth of an inch, so that the weight was no longer on the steel pins, which were then drawn out and placed in the link holes a foot higher up. By means of a suitable arrangement of cocks the water was let out of the rams—first on one side and then on the other—and the pier lowered until the steel pins again rested on their bearings. The crossheads were then disconnected, and the rams pumped up again to the top of the stroke. As the lowering proceeded, links four feet long were added, and the whole apparatus, though weighing, as we have said, something like 140 tons, was under such perfect control that the workmen handled it with the ease and precision of a small model. It was lowered about one foot every five minutes, so that by full ebb it was grounded on the bed of the river. During its settlement amongst the silt the pier was carefully watched with a spirit-level, and any tendency to sink unequally was promptly checked by the hydraulic rams being pumped up on the lower side of the pier until the settlement became equal.

COMBINATION OF AEROSTATIC AND HYDRAULIC APPARATUS.

When once the pier had been fairly settled on its proper site—which was ascertained by sighting lines from the shore and a measuring chain from the last pier—temporary cast and wrought iron caissons were fixed upon it, so as to bring it up to about six feet above high water level, and the brickwork was then carried up some distance until a sufficient weight was obtained to prevent the possibility of the pier floating when it was filled with air during the process of sinking it to the rock foundation.

This operation was effected by means of two air bells, with pumps and engines attached, which were fixed to the top of the caissons. A strong current of air was pumped down the shafts of the piers until the water was driven out of the chamber at the bottom, to which the workmen then descended, without the necessity of wearing a diving dress, and excavated the soil. The sand and gravel were then sent to the top in buckets through lock-shoots in the air bells, and thrown into the river. As the excavation proceeded, the pier necessarily sank by its own weight, and the precaution was taken to steady it by means of two hydraulic telescopic legs, and also by heavy iron chains running out from the last finished pier. When the rock was reached the foundation was, first of all, properly levelled. The working chamber was then filled up with concrete under air pressure, the flanges carrying the brickwork being carefully packed and run in with cement concrete. The shafts were next filled up, and the air-bells and temporary caissons being removed, the brickwork was carried up to the requisite height. Working according to this improved plan, the construction of the piers was steadily carried forward; but new and unforeseen difficulties lay ahead.

DIFFICULTIES WITH THE FOUNDATIONS.

When the practicability of building the Bridge was first under consideration preliminary borings were made to ascertain the nature of the bed of the river, and whether there was a likelihood of rock or hard beds of clay or gravel being accessible for the foundations of the piers. The result of these operations led the engineers to believe that the rock would be found at moderate depths over the greater part of the river's bed, and that where it could not be obtained for a foundation there were sufficiently hard strata of clay or gravel to form a good substitute. In carrying out the work, however, it was found after the fourteenth pier had been built that the rock suddenly dipped to a depth which was practically inaccessible, a discovery which led to a complete change in the mode of procedure. No. 15 pier proved a most unfortunate one for the builders. Like the others it was formed of two cylinders, but being founded just where the rock dipped

down, it began to cant over after being partially finished, and had ultimately to be blown down, and a new foundation prepared by means of piling.

SUBSTITUTION OF IRON COLUMNS FOR BRICK SUPERSTRUCTURE.

The original plan contemplated the erection of solid brick piers for supporting the girders over the greater part of the river, it being understood that rock foundations would be obtained; and the altered condition of things rendered it imperative on the contractors not only to form an artificial rock foundation, but at the same time to lessen the top weight. The latter object was gained by substituting groups of iron columns in lieu of the solid brick above the level of high water, while an artificial rock foundation was secured by forming an oval bed of concrete, 23½ feet by 13½ feet and about 20 feet in thickness. A sufficiently hard stratum of clay or gravel for the support of these concrete beds was generally found about eighteen feet deep, but in the case of five of the sites the strata were so soft and yielding that piles forty feet long had in the first place to be driven into the ground to ensure a reliable bottom—a work which was performed by experienced pile-drivers, who were brought over from Holland for this special purpose. For the formation of one of these artificial rock foundations a caisson composed of malleable iron plates 20 feet high was first constructed on the level floor on the beach, and inside of this a brick lining, 14 inches thick, without any bottom, was constructed. After the lining had been completed the caisson was built with iron to the further height of 20 feet; but as this was only a temporary part of the structure, used to facilitate the sinking process, and at the same time to protect the workmen from the strength of the current (which runs at the rate of four miles an hour), no brickwork lining was added. The caisson, 40 feet in height, and weighing about 50 tons, was then lowered to its site in the bed of the river by means of hydraulic apparatus. As it had been decided to abandon the pneumatic process for sinking these caissons, several other expedients were tried with varying success; but at last the right plan—and a very effective one it proved to be—was hit upon by Mr Reeves.

ANOTHER EXPEDIENT ADOPTED—A PATENT SAND-PUMP.

His method was to have a small lighter, on which were placed four cylindrical receivers of wrought iron, each about 5 feet in diameter, with the necessary engines and air-pumps for exhausting them. The bottom of each receiver was fitted with a door opening outwards over a hopper, and the tops communicated by means of the necessary pipes and cocks with a pair of flexible tubes (of indiarubber) sufficiently long to extend over the sides of the lighter and down into the interior of the caisson. The latter having been lowered to the bed of the river, the lighter was moored at the spot, and divers then descended with the indiarubber pipes, which they guided amongst the sand in the centre of the cylinder, taking care not to allow it to burrow too deeply so as to become choked. The extremities of the hose were guarded with strong copper wire as a precaution against stones, &c., being drawn up and coming into contact with the valves and other working parts. When everything was ready, the connections with the receivers were opened successively, and up rushed the silt and water through the hose until one of the receivers was full, and the contents then emptied themselves into the hopper. About two and a-half minutes sufficed to fill a receiver—sand forming a third of the contents—and as during this time the engine was exhausting one of the other receivers, the work was carried on continuously. By means of this patent sand-pump, about 100 tons of material were raised daily. Of course as the soil was removed from the interior the caisson gradually sank by its own weight, and at a depth of 18 or 19 feet a sufficiently reliable stratum of clay or gravel was generally reached.

FILLING THE CAISSONS WITH CONCRETE.

The next operation was to pack the caisson with concrete, and when this had been done, and a mound of rubble raised round the base to protect it from the scour of the river, the result was the formation of a solid foundation equal to rock, and capable of sustaining the immense weight of the superstructure. Thereafter the temporary part of the caisson was removed, leaving the concrete foundation projecting about a foot above the bed of

the river, ready for the reception of the pier. The lower portion of the pier, permanently under water, was built on shore of brick work in cement, with the centre left hollow in order to reduce the immense weight. In shape it was somewhat like an elongated hexagon, measuring 20 feet in the direction of the current, with a width of 10 feet. Being about 22 feet in depth, the brick work, when securely fixed on the concrete foundation, had its top about level with the surface of the water at ebb tides, so that the workmen had no difficulty, when the state of the tide permitted, in filling up the cavity with concrete and building an additional 14½ feet of solid brick work, raising the pier to the level of high water. Four courses of Carmyllie stone, of an aggregate thickness of five feet, were then added to finish off the structure and form a substantial basement for the upper works. These consisted of six iron columns, of 12 inches and 15 inches diameter, cast in lengths of 10 feet, which were securely bolted together and made fast to each other by strong vertical and diagonal braces. Fourteen piers built according to this style brought the works out to the navigable part of the river.

LENGTHENING OF THE CENTRAL SPANS—VARIATION OF DETAILS.

The spans over this portion were originally designed to be 200 feet long, but various circumstances conspired to render it expedient that the length should be considerably increased, the number of the piers being of course proportionately lessened. As the result of the deliberations of the engineers on the subject, it was resolved to modify the original design to the extent of lessening the number of piers from 89 to 85, and increasing the width of the central spans from 200 to 245 feet. Owing to the immense weight of the girders (190 tons) for each of these spans, it was necessary to enlarge the artificial rock foundation, which was effected by substituting for the oval platform a circular bed of concrete, with the diameter extended to 31 feet. A caisson of this description, 45 feet high and 31 feet broad, very much resembled a large gasholder. It was formed of wrought-iron, the lower portion, to the extent of 20 feet, which was meant to penetrate into the bed of the river, being stiffened with a ring of brickwork 14 inches thick. When floated out it weighed nearly 200 tons, and four rams—each capable of lifting 100 tons—

were used in lowering it to the bed of the river. To effect its settlement into the silt until a reliable stratum was found, the sand pumps had to be brought into requisition, and the interior was then filled in the usual way with concrete. On this platform a hexagonal piece of brickwork, 22 feet in height, 16 feet wide, and 27 feet in the direction of the current, was subsequently fixed, bringing the structure up to the level of the ebb tides, and the brickwork and masonry were thereafter built up a little above high water level. The diameter of the six iron columns (rising 80 feet above the masonry) which constituted the upper works was enlarged to correspond with the increased weight of the girders to be supported—the four central pillars being increased to 15 inches, and the two outer ones up and down in the direction of the current to 18 inches. In the construction of these huge piers in the navigable portion of the stream it was of great importance that as little obstruction as possible should be presented to the current, and accordingly the starlings—those parts of the pier facing the current—were made like the cutwater of a ship. So far as is known at present, the construction of the piers has not prejudicially affected the scour of the river, and the predictions of our local Micaiahs that the erection of the Bridge would lead to the formation of numberless sand-banks, have been fortunately entirely falsified. To the northward of the thirteen wide spans in the deep-water channel the piers, resting on a gravel foundation, were built on the double-cylinder principle—the diameter of the cylinders being 15 feet—while the upper works consisted of six coupled columns of 12 inches and 15 inches diameter.

THE PIERS AT THE NORTH CURVE.

A different principle had to be adopted in forming the piers on the curved portion of the Bridge at the north end, the water there being for the most part comparatively shallow, owing to the accumulation of numerous sandbanks. Each of these piers was composed of three cast-iron piles, two of them vertical, placed nine feet apart, and the third forming a stay on the west side to resist the outward thrust of trains passing round the curve. According to their height and the weight of the girders they have to carry, these piles vary from 1 foot 4 inches to 1 foot 8 inches in

diameter, and consist of cast-metal one inch thick, braced together with horizontal and diagonal braces. In sinking these piles the plan adopted was that invented by Mr Brunlees, namely, pumping water at high-pressure through them, by which means the sand was washed out until the foundation of blue clay was reached. Each pile had a base 3 feet 10 inches in diameter, bolted to the bottom, provided with a hole in the centre and teeth on its bottom surface, the pile being guided by a wrought-iron staging, furnished with revolving gear for turning the pile whilst the water was being pumped through. This system had, however, to be modified during the progress of the work, as layers of peat and boulders were encountered through which the piles could not penetrate. Cylinders of 6 feet diameter were sunk by means of the sand pump in the manner as described for the large caissons, and in these cylinders the columns were fixed and surrounded by concrete.

THE IRON LATTICE-GIRDERS—METHOD OF FLOATING THEM OUT.

Having referred at length to the building of the piers, which presented the most formidable difficulties to the engineers, we come now to speak of the superstructure. Looked at from a distance, it may seem that the iron-work is very light, but it is not so in reality. Wrought iron has been used in bridge-building for many years, and the duty of the engineer now includes not the mere calculation of the strength of a girder, but the selection of that system which combines the greatest strength with the least waste of material. For the Tay Bridge the latticed-girder was employed, as giving the requisite strength and lateral stiffness ; and to ensure the quality of the material no piece of iron was used unless it could withstand a tensile strain of 21 tons to the square inch. The pieces of iron forming the girders were erected and riveted together on a staging near the shore, and connected to it by a gangway. Each span had four horizontal pieces or booms, two at the top and two at the bottom, and four vertical posts at the ends, the booms being of the trough section, and varying from 12 inches to 21 inches in width. Nine crosses, consisting of struts and tie-bars, kept the booms at the proper distance, and transmitted the strain to the ends to be supported by the piers. In the case of the largest

spans the struts were of H section, and in the shorter spans of channel section. The smaller sized girders were 16½ feet deep. For the 245 feet spans, however, the two girders forming each span were 27 feet deep, and of an aggregate weight of 190 tons, and the work of erecting and riveting them on the staging required four weeks to accomplish, about 18,000 rivets having to be put in each. One of these spans being completed, part of the staging was taken away at either end, barges were then introduced into the gaps, and at high water the mass of ironwork was towed out and moored in position with the ends above the piers on which they were permanently to rest. As the tide fell the girders settled on the piers, and the barges were then withdrawn. The raising of the girders was effected by means of hydraulic apparatus, placed on stages bolted between the columns, and the services of eighty men were required to raise the span twenty feet a-day—the usual rate of progress. While some of the men worked the pumps to supply the pressure for the hydraulic apparatus, others manipulated the various cocks and pins by which the weight was alternately released and taken by the rams, and a set of machinery had at the same time to be got ready at a higher stage to be brought into requisition when the girder reached that point. The upward progress of the girders had to be carefully watched lest the ends should come into contact with the projecting parts of the columns, and the bracings connecting these with each other had to be put in as the girders rose. When the spans had reached their full height the heads of the columns were firmly connected with a set of girders carrying the bedplates, but before the weight would be put on these the span had, in the first place, to be connected with the one adjoining it. To raise the girders of the brick piers the plan adopted was to use "jacks," which lifted the ironwork two feet at a time. Pieces of wood were inserted in place of the "jacks," and the brickwork was thus carried on, bit by bit, until the structure was completed.

PROVISION FOR EXPANSION AND CONTRACTION.

In the construction of the girders due provision had to be made for the expansion of the iron by heat, which is reckoned at seven

feet over the whole length of the bridge. To meet this the spans were arranged in sets of four, five, or six, each set being provided with its own fixed and expansion bearings, admitting of self-adjustment at twenty-one different places. In each group only one of the piers is permanently fixed to the superstructure, the ends of the girders meeting on it being firmly bolted down, while at the other piers of the set the girders rest on rollers, over which they can slide longitudinally when expansion or contraction takes place, according to the varying conditions of temperature.

THE RAILS—FLOORING—HANDRAIL—TELEGRAPH WIRES.

The roadway over the bridge is on the top of the girders, except in the wide spans in the centre of the river, where it is carried along the lower booms, giving this portion somewhat of the appearance of a tubular bridge. The permanent way consists of double-headed steel rails, fished at the joints, in 24 feet lengths, weighing 75 lbs. to the yard, secured by oak-keys in cast-iron chairs, fixed at 3 feet average intervals to longitudinal timbers 17 inches wide, and varying in depth from 7 to 14 inches. Throughout the entire length of the bridge each rail is provided with a guard-rail, as a precaution against any of the vehicles leaving the line. Between the longitudinals the floor of the bridge consists of 3-inch planking, covered with a waterproof composition, which besides preventing the leakage of water will also serve to preserve the wood from catching fire from the hot ashes falling from the engines. To prevent corrosion the whole of the ironwork has been coated with black varnish, specially prepared; and in connection with this the strange fact deserves mention that in the Tay, whose waters are partly salt and partly fresh, the corrosion of iron is much greater than would be the case if the river were either wholly salt or wholly fresh. A substantial handrail, which can be utilised as a gaspipe if necessary, has been placed along either side of the bridge for the protection of the officials in walking along the line; and an iron tube containing thirteen telegraph wires, boxed in with wood, has been laid along the flooring on one side—this direct route having been selected as preferable to the cable across the river at Harecraigs, which was very liable to breakage by the anchors of ships.

HEIGHT OF THE PIERS AND GIRDERS.

The deepest part of the river is at No. 22 pier, about 2200 feet from the Fife shore, where the depth at high water during spring tides reaches from 40 to 45 feet. It is estimated that the rise and fall of the tide varies from 12 to 17 feet, and the current in that part of the river crossed by the bridge is reckoned about four miles per hour. The greatest height of pillar occurs at the first of the wide spans on the south side, the extreme height from the foundation in the bed of the river to the underside of the girder being 142 feet. Adding to this the depth of the girder, 27 feet, gives a total of 169 feet—figures which help to convey an idea of the stupendous character of the work.

ELEMENTAL DIFFICULTIES—STORMY WEATHER.

Owing to the numerous difficulties which arose, and the various changes that had to be made in the mode of building and sinking the piers, the progress, during the first three years especially, was by no means so rapid as had been anticipated by the more sanguine shareholders, who seemed to have expected to see the structure reared like a fabric in fairyland. Mr Grothe was the last man to sacrifice substantial workmanship for the sake of expedition, and the result of his labours and forethought is the strong and useful bridge, which has borne the severe tests to which it was subjected by the Government Inspector without the least injury. From beginning to end the work was carried on in a steady irresistible way, in spite of the most formidable obstacles ; and even disasters, which to some might have seemed almost overwhelming, served only to call forth the more energy and to stimulate to increased activity—Mr Grothe's indomitable buoyancy bearing him up under the most depressing circumstances. According to their conditions, the contractors were to have the bridge completed in the course of three years ; but at the expiry of that period the structure was barely half-finished, and an extension of time had to be applied for to Parliament. The weather must be credited to a large extent with the delay. Without seeking to traduce the elements, it must be confessed that it did seem as if they were determined to try their best—or rather their worst—to undo the

work of the builders, and defeat their efforts to link the counties of Forfar and Fife in the iron embrace of a railroad. In proof of the adverse character of the weather, a reference to Mr Grothe's diary shows that not unfrequently only five or six favourable working days could be pointed out in the course of a whole month. At the very threshold of the undertaking—within a month from the date of the foundation-stone ceremony—the contractors experienced a foretaste of the weather, a storm having suddenly burst forth and caused material damage to a number of barges, &c., which were driven from their moorings by the strength of the gale. The first two winters were characterised by exceedingly high winds. On one occasion (in 1872) a north-westerly gale blew continuously for three weeks, completely stopping all work connected with the pier, and at another time the extreme frost caused a cessation of all building operations.

ENERGY OF THE NEW CONTRACTORS.

The death of Mr Charles de Bergue, the contractor, which happened on the 10th April 1873, led his trustees to arrange with the North British Railway Company for relinquishing the contract, which in July 1874 was assigned to Messrs Hopkins, Gilkes, & Co. (Limited), of the Teesside Iron Works, Middlesborough. That firm had acquired great experience in bridge-building, and their abundant resources fitted them in an especial manner for carrying out the contract to a speedy and successful issue. They had recently built a bridge with a single span of 215 feet for a railway in Finland; the viaduct across the valley at Saltburn was of their construction; several large bridges on the Maidstone and Seven Oaks Railway had just been completed, and they were then busy with a series of wrought and cast-iron bridges for the Leeds and Wetherly line. At this time Mr Austin left to become manager of the works at Cardiff belonging to the De Bergue firm, and Mr Grothe became sole manager of the Tay Bridge Contract. The speedy opening of a foundry to furnish the necessary castings on the spot, instead of having to wait their being forwarded from England, together with a large addition to the plant, showed conclusively that the new contractors meant to carry on the work with the utmost energy. Mr Edgar Gilkes undertook the

superintendence of the Contract, which was carried out from the beginning to the end under his personal supervision, and the satisfactory result must be no small recompense for the care and anxiety which a work of such magnitude necessarily involved.

USE OF THE ELECTRIC LIGHT.

During the summer of 1874 the work was rapidly pushed on, but the winter was exceptionally severe, so that for three months no work could be done outside the jetties. In the course of 1875 the work was carried on very satisfactorily, and in April 1876 the first of the large girders was floated out and successfully laid on the piers built for its reception. By August that year 76 out of the 85 piers had been placed, and only 18 girders required to be taken out to fill up the gaps. In the autumn and winter months of 1876 two electric lights were brought into operation to forward the work, each of these lights having an illuminating power equal to 1000 candles. The current was generated by two of Gramme's electro-magnetic machines, driven by an engine of four horse-power. Placed on an eminence and provided with parabolic reflectors, these lights had a powerful effect, and by their means the men were able to carry on their work on the jetties and in the yard without interruption. The floating out of the last pier took place on the 26th December 1876, and the occasion was made one of some little ceremony. In the course of 1877 from 500 to 600 men were engaged in the different departments, the laying of the platform and rails being carried forward simultaneously with the erection of the girders. On the 1st August 1877 the last girder was floated out; and the promise made in 1876 by Mr Grothe that a train would pass over the bridge by September 1877 was fulfilled, the first train containing the Railway Directors and others having crossed on Saturday, 22d September. The visitors on their arrival at Dundee were greeted by the enthusiastic cheers of an immense multitude who congregated on the Esplanade and Magdalen Green to witness the first passage of a passenger train along the Bridge. On the 25th, 26th, and 27th February this year Major-General Hutchinson, Government Inspector, examined the Bridge, and the satisfactory result of his tests with six locomotive engines and tenders, weighing altogether 438 tons, proved the perfect stability of the structure.

CASUALTIES—EXPLOSION OF A CYLINDER—FALL OF TWO GIRDERS.

In a work such as the erection of the Tay Bridge a serious casualty list was regarded as inevitable; but, taking into account the large number of men employed—ranging at times from 100 to 600—and the extremely hazardous nature of the duties they were called upon to perform, it must be admitted that the roll is not nearly so heavy as many feared it would be. This result has been due in great measure to the fact that Mr Grothe made the safety of the men employed at the Bridge his first consideration, all other questions being rendered subservient to the comfort and security of the workmen. Of the comparatively minor accidents, we have already referred to the capsizing of three of the cylinders at the south side in consequence of their small bearing surface and unequal settlement amongst the silt and boulders. By the toppling over of a cylinder of No. 7 pier the air-bell and engine were precipitated into the water, two of the workmen making a miraculous escape. While No. 14 pier was being filled with concrete the escape-cock for the air became choked, and the excessive pressure of the air pumped into the cylinder—varying from 12 lbs. to 20 lbs. to the square inch—caused one of the plates of the temporary caisson to give way, in consequence of which the air-bell and engine fell, and two of the men sustained severe injuries. The most disastrous calamity in the history of the bridge happened between two and three o'clock on the morning of the 26th August 1873. Nine men were employed at that hour excavating the sand in No. 54 pier, about a quarter of a mile from the north shore, when, without the least warning, the cylinder exploded and six of the men lost their lives. A searching inquiry was made regarding the sad occurrence but the exact cause of the explosion was never satisfactorily ascertained. The accident by which the most serious injury was done to the Bridge happened on the night of the 2d February 1877, so graphically described by Mr Grothe in *Good Words*:—

"Since 1877," says Mr Grothe, "the storm had not raged with such fierceness as on the night of February 2d, 1877. Without any barometrical warning it came down at four o'clock in the afternoon with an unparalleled suddenness. No gradual growth, no preliminary showers, heralded its

approach. It was just high water, and a very high spring-tide it was. A steamer was sent to take the men off the piers, but could not even get near them. The large pontoons in the harbour on the south side and several barges were torn from their moorings, and only secured with the greatest difficulty, the sea washing right over the landing jetty and stagings. It was now quite dark, and nothing could be done to release the forty men yet out on the high girders. They could come down from that position to one of the adjacent girders which had not yet been lifted, but as a small 'bothy' had been erected on the high one it was probable that they would seek shelter there. The Sunday before the girders had weathered a very heavy gale without being at all affected by it; but if ever anything could happen it was in the position in which they were now. By eight o'clock the steamer Excelsior made another attempt to reach the men, or at any rate to get near enough to speak to them and show them that they had not been forgotten. When within two hundred yards of the spot the crew heard a frightful crash and then a splash in the water which sent the spray over the deck. They knew that at least one girder had come down, but a fire on the lower one reassured them about the fate of at least some of the men. Loose planks and wreckage now came down upon the steamer, and she had to hold off again, and it was not till four o'clock in the morning that the sufferers were at last taken on board and brought to Dundee, where anxious wives and mothers were waiting for them on the quay. With the exception of one all were saved. Not one had been on the fallen girders, though a few went up but a short time before the catastrophe to get their coats. The missing man had been seen shortly before the steamer arrived, and must have fallen off the pier or missed his footing at the embarkation. In the prevailing darkness and confusion this might easily have happened without being noticed. The foreman had one of his legs broken, but none of the others were hurt, and the chief anxiety, that many or all of them might have lost their lives, was fortunately allayed. At daybreak the full extent of the disaster could be realised. Two of the large spans and one girder of the one hundred and forty-five feet span adjoining them, together more than four hundred tons weight, had come down. The iron part of the piers on which they were supported was completely wrecked, but fortunately the brick and stone part of the piers was uninjured. The accident was, doubtless, a very serious one; but the thought that it might have been ever so much worse, and that after all the loss of property was nothing compared to all the human lives which had so mercifully been saved, was a great consolation."

ILLUSTRATION OF THE DIFFICULIES ENCOUNTERED.

One of the girders which fell on that occasion had previously given no little trouble to the engineers. Recurring again to Mr Grothe's sketch, we extract his account of the perilous voyage he

made on the girder in question, as it conveys to the uninitiated a capital illustration of the dangers and difficulties which had to be contended against :—

"A steady breeze was blowing (23d August 1876), but as the floating out of the girder had already been delayed a couple of days, it was resolved to take it out notwithstanding. As high water would occur at seven o'clock in the evening, the barges were put in the gaps of the staging under the girder at four o'clock, and shortly after touched it and began to take the load. At six o'clock it was high enough to be floated away, but as the current was yet too strong it had to wait. In order to counteract the westerly breeze to some extent by the last of the flood-tide, it was towed away at half-past six. The wind had in the meantime risen to half a gale ; but the barges with their strange load proved to be quite seaworthy, and the operation would not have been marked by any extraordinary circumstances had both the tug steamers been equally well prepared for the work. But one of them had been hired for the occasion and was not well arranged for towing. She soon turned out to be quite useless, and the other was not able to keep the girder broadside on against the wind, even with the tide in its favour. The structure was blown down the river, to the dismay of a number of interested spectators on board the steamer and of the on-lookers on shore. In order to offer as little surface to the wind as posible, the girder was put end on, but as the ebb tide had now set in all it could do was to retard the downward course. Another trial was made to get help from the second steamer, but the crew had evidently got demoralised, and the high wind made it impossible to make the orders given from the girder understood by those on board. One rope after another snapped, and every time the chance of reaching the piers, or even a sheltered place for the night, was lessened. The girder had already drifted more than a mile, and would soon come to the mouth of the river. Darkness was fast setting in, the tide was flowing away, and would soon be too low to float the girder over the top of the piers on which by this time it should have rested. It was a very anxious time for those "on board." It was difficult to tell what would happen, but all the contingencies were bad ones, the probability of mooring the barges with their freight in the river and riding out the gale being one of the most favourable suppositions. If the weather did not get worse and heavy anchors could be procured soon enough, this might be done ; and one of the launches had been despatched for the purpose of getting them, while the other was away to Dundee to get another tug if possible. In the meantime the spectators had left in the second steamer, as it had become quite dark. Not one of them was prepared to see the girder next morning in its proper place ; but as soon as the harbour steamer arrived in response to the summons for assistance, a temporary lull set in, and the two tugs managed to get the girder up to the place just in time. Five minutes later and the piers would have been too high out of the water.

As it was, it was safely resting on them by eleven o'clock, and the barges were withdrawn soon after and taken into the harbour."

THE USES OF CEMENT AND CONCRETE.

It will have been observed from the foregoing account that cement has had a very conspicuous part assigned to it in the formation of the bridge. So important has it been, indeed, that we have it on the authority of Mr Grothe, in his admirable papers which appeared in *Good Words*, that "without this, or some substance of similar properties, the building of the Tay Bridge would in all probability have been impossible." Cement in its ordinary state is a fine greenish-grey powder, which when mixed with water remains pliable long enough for working purposes, after which it sets and becomes as hard as stone. In consequence of this peculiar property it is of essential value in the construction of works under water, as it hardens even better by immersion than by exposure to the atmosphere. A striking illustration of its adhesive properties was shown in the case of the pillars, built of brick set in cement, at the south end of the bridge, which were overset during the course of construction, and required to be fished out of the river. Though built only a few weeks previously, the pillars had acquired the solidity of rock, and it was found impossible to break them up except by heavy charges of dynamite. With material of so much importance to the success of the work, it was necessary that the contractors should take every precaution to ensure that in point of quality it always came up to the required standard. For this purpose, one in every 10 barrels, chosen promiscuously, was tested both for weight and quality. The condition was that a test piece of cement, with a section of 2¼ square inches, after immersion for seven days, should stand a strain of 563 lbs., and the admirable quality of the material was abundantly proved by repeated experiments, the records of which show that the average breaking point reached 720 lbs., or 157 lbs. above the specified strength. The testing of the cement was a very interesting sight to spectators, and the illustrations of the process given by Mr Grothe at the works, and also at several of his lectures, will be remembered with pleasure by those who had the privilege of witnessing them. Amongst several of the many tests made, it may be mentioned, as

showing the effects of immersion, that a piece of cement which had been two months in water was subjected to a strain of half-a-ton before it yielded to the pressure. On another occasion a test piece 1½ inches square did not break until the pressure registered 1120 lbs.; while a block three days old bore a strain of 410 lbs., and one of seven days a pressure of 1000 lbs. Cement, when mixed with sand and broken stones, in the proportion of one part of cement to five parts of the other material, forms what is known as concrete, which takes the form of the cavity into which it is packed, and becomes a hard and solid body in the course of a few days. The artificial foundations of the piers in the centre of the river are formed of concrete, and a considerable part of the piers under water is composed of the same material.

SATISFACTORY ARRANGEMENTS OF THE CONTRACTORS' ACCOUNTS.

It is worthy of remark that probably no undertaking of anything like the same magnitude was ever completed and the accounts as between employers and contractors so easily and amicably adjusted. Indeed, the final settlement between the North British Railway Company and Messrs Hopkins, Gilkes, & Co., the contractors, did not occupy more than half-an-hour. This very satisfactory result was owing very much to the careful mnaner in which Mr Paterson, the Resident Engineer on behalf of the Railway Company, saw to the accurate keeping of the detailed accounts from the commencement of the work till its completion. No disputes or misunderstandings were allowed to remain; every question as it arose was deliberately considered and definitively decided to the mutual satisfaction of parties, so that no "open questions" remained to be discussed at the final settlement. The accounts had been kept from day to day, and instalments paid every month, so that at the end it was the last month's accounts only which had to be considered, and when these were arranged nothing remained to be done but to pay over the balance of the schedule rates which had been kept in hand by the Railway Company in accordance with the conditions of the contract. Considering that the detailed accounts to the contractors amounted to more than a quarter of a million sterling, nothing could be more creditable to both parties than the facts just mentioned.

MATERIALS.

A good idea of the stupendous character of the undertaking is afforded by the fact that in the construction of the Bridge there were used—3520 tons of cast iron, 6281 tons of malleable iron, 90,600 cubic feet of timber, 8600 tons of cement, 4,350,000 bricks, 27,000 cubic feet of dressed ashlar, and 355 cubic yards of rough ashlar.

VISITS OF DISTINGUISHED PERSONAGES.

During its construction the bridge was visited by people of all ranks, and from almost all parts of the world. The only member of the Royal Family of this country who has inspected the bridge is Prince Leopold, who, while the guest of Mr Whyte Melville, Convener of Fifeshire, made a trip to Dundee for the special purpose of examining the structure, in the working details of which he took deep interest. The Emperor of Brazil, who has done so much to develop the vast resources of his empire by the construction of railways and the encouragement of arts and manufactures, showed his interest in the bridge by paying a special visit, at much personal inconvenience, on the morning of 3d July 1877. General Grant, the ex-President of the United States, journeyed to Dundee on the 1st September 1877, and spent some time on the bridge. Mr Gilkes, of the firm of Messrs Hopkins, Gilkes, & Co., was in attendance on the latter occasion, and presented to General Grant a handsome album, containing photographs of the bridge in its various stages of construction. Captain Wentzel, of the Royal Guards of the King of Holland, visited the bridge at an early stage, and took part in the proceedings at the opening of the workmen's dining-hall. General Delprat, of the Dutch Army, was also present when the first train ran across. Of course the Bridge was a source of great interest to engineers, and excursion parties from the Cleveland Institute of Engineers, the Institution of Engineers and Shipbuilders in Scotland, the Engineers of the North Eastern Railway Company, and many other bodies visited it frequently. Having such a deep interest in the undertaking, the Chairman and Directors of the North British Railway Company paid frequent visits, along with

ex-Provost Cox, the Chairman of the Tay Bridge Company, who may be said to have been the prime mover and mainstay of the work. During one of these official visits, Mr W. P. Adam, M.P., and Mr Yeaman, M.P., descended one of the cylinders, from which the water was driven out by the air-compression system, and witnessed the mode of excavating the soil.

The Rev. Mr Thomson, Forgan, may be appropriately styled the chaplain of the Bridge. He was present at the laying of the foundation-stone, and opened the proceedings with prayer, and throughout the six years occupied in building the Bridge he took a most intelligent interest in the various working details. On the occasion of the floating out of the last girder, which heralded the successful completion of the undertaking, Mr Thomson was one of the company present at the interesting ceremony; and as he had opened the proceedings with prayer when the foundation-stone was laid, he offered up thanks that the work had been brought that day to such a satisfactory termination.

LEUCHARS TO THE TAY BRIDGE.

The Tay Bridge is connected with the main line of the North British Railway by a branch line, extending in a north-westerly direction from the village of Leuchars to the farm of Wormit, and measuring $5\frac{3}{4}$ miles. It was originally intended that the junction of the new and old lines should be much simpler than what has been actually carried out, and that the formation of the new works should not interfere with the track of the main line. At the point, however, from which the branch starts has been fixed the junction for the St Andrews line—recently acquired by the Company—and to meet the requirements of the heavy passenger and goods traffic considerable modifications have been made upon the original design, so as to secure the most complete arrangements for the accommodation of passengers and the expeditious transit and removal of minerals and goods. The effect has been to make the new line appear as the natural continuation of the main line, and that part of the system extending to Tayport as a branch only. The new buildings which have been erected by Mr Bruce, of St Andrews, are remarkably neat and complete in design, and as a "roadside" station are very creditable to the Company.

The station offices and rooms are placed in the centre of the platform, and can be entered from both sides. The walls are of brick, with freestone-dressed corners and rybats, &c., the description of work being somewhat similar to that adopted in the construction of the new station at Dundee. The roof over the platform is of iron, latticed, and is glazed throughout. A complete suite of waiting-rooms handsomely finished have been provided, and as the refreshment rooms, leased by Mr Orchison, of Arbroath, have been licensed, the general accommodation at this junction will not be excelled at any out-lying station in Scotland. The platforms are very extensive, the total length of walling being 3360 feet, which has been coped throughout with neatly dressed flagstone from Mr Langlands' Quarry at Myreton. The "up" and "down" lines pass alongside the north and south platforms, but the Company has provided for local trains by special docks. The new line starts at a point near the farmhouse of Milton, and is double throughout. Curving northwards upon a radius of half-a-mile, it passes St Michaels close to the inn, and at this point Cupar turnpike road has been diverted under the railway. The Company having secured additional land at St Michaels, it is probable that, in the event of the adjacent grounds being acquired for feuing purposes or otherwise requiring train service, a station with the necessary sidings will be set down. It may be stated generally that the line has not presented any formidable engineering difficulties, although several rather heavy cuttings have been necessary. The heaviest of these are upon the section to which we have just referred, and the nature of them may be estimated by the fact that one of them contained upwards of 50,000 cubic yards. Leaving St Michaels, the line runs through an old wood there, and crosses the Motray water at a distance from Leuchars of three and a half miles. Taking advantage of a contour of the land here, the line makes a sweep along the shoulder of what appears to have been the slopes of an ancient estuary, and again crosses the Motray three and a half miles from the junction going within 150 yards of Bogton, where a station, with agricultural sidings, is set down. This station has been named "St Fort," after the estate on which it is built. "Up" and "down" platforms have been provided to a total length of 800 feet, and the passenger accommodation on both sides of the line is very

complete. The buildings, which are almost exclusively built of brick, have a neat appearance, and include the station agent's dwelling-house. To the south of the station buildings are placed extensive loading-banks and sidings, with the necessary approaches. At St Fort there has been a considerable diversion of road, and the line crosses the turnpike at Newton Farm on a substantial iron bridge. From Newton Road to the south end of the Tay Bridge, the distance being about a mile and a quarter, the line curves in a north-westerly direction.

THE WORMIT SIDING AND GOODS YARD.

At Wormit Farm the North British Company acquired a considerable portion of ground, which will be utilised for siding and mineral depots. These sidings, which will run generally parallel to the main line, will extend back from the south end of the Tay Bridge for a distance of fully 600 yards, and will occupy a breadth of land of nearly 80 yards. They will be used principally for the storage of coals, minerals, and other goods traffic, and for the marshalling of trains going north and south, and will be provided with engine sheds and other appendages of a goods yard. There is every probability that when all the arrangements for this yard have been carried out, this part of the line will present a very lively appearance, and the neighbourhood must ultimately become a well-populated village. Here the turnpike has been diverted towards the eastward, where a good deal of heavy cutting fell to be executed; and it will be regarded as somewhat surprising that in so short a line there should be no fewer than eighteen bridges. One is situated at the occupation road at Leuchars, one at the occupation road road between Leuchars and St Michaels, one at St Michaels itself, three on the farm of Strathburn, two over the Motray, four on the farm of Straitton, one at St Fort, one at Newton, one at the Gauldry road, and three on the farm of Wormit. The line passes either over or under all these bridges. Almost all the road diversions have been made in order to suit the approaches to the several farms, and the district will really be improved in the way of roads, while it will have the important advantage of an extensive railway service. The gradients over the whole line are particularly easy, the steepest being one in one hundred, there

being large tracts on one in seven hundred, and for a conrableside length the line is level. These favourable gradients have been secured without the expense of extraordinary cuttings or embankments ; and the line being carried through lands which for the most part were of less than ordinary agricultural value, the comparative cheapness of its construction and the minimising of the working expenses by the laying down of easy gradients prove the thorough efficiency of the Engineering department of the Company. The district traversed by the railway being of the agricultural character referred to does not present any feature of special interest. Shortly before reaching the Bridge, however, the stranger obtains a view of the expansive waters of the Tay, and cannot fail to appreciate the beautiful situation of the town of Dundee. The practical management of the works on this section of the scheme has been carried out by Mr Robert Donald, while the engineering department has been undertaken by Mr Waddell's staff at Dundee.

THE ESPLANADE WORKS.

While the construction of the tunnel was being proceeded with large squads of men were engaged in the carrying out of the necessary works in the Esplanade grounds connected with the scheme. It will be remembered that little more than five years ago the space enclosed by the Esplanade river wall presented the appearance of a large loch. In this space the tide rose at high water to a height of twelve feet, while at low water it was a sheet of mud furrowed by drains—the mud generally lying to a depth of from 4 to 8 feet on a substratum of sand—the original foreshore of the Tay. The operations in this space being subject to the rise and fall of the tides, were of an extremely laborious character, and yet within three years there have been built on it a viaduct 1020 feet long, 4000 feet of 5 feet thick retaining walls, the splendid new station and platforms, the magnificent new goods shed and the hydraulic buildings, while there have been laid down permanently on substantial embankments upwards of ten miles of railway. The viaduct consists of thirty-seven spans, three of which are composed of iron girders forming the north end of the Tay Bridge, which were erected by Hopkins, Gilkes, & Co., as sub-contractors under Mr Waddell. The rest of the viaduct, which has been built

by Mr Waddell, is constructed for double line, and consists of thirty-four arches, of 26 feet span each. The piers are carried down through the mud to a depth of 12 feet, the foundations being of solid cement concrete, every foundation requiring a coffer-dam for itself. The viaduct is built on a gradient of 1 in 74. The retaining walls referred to form the boundary of the station ground proper. Their construction was intended not only for the purpose of supporting the embankments, but also for keeping the tidal water out of the station. For these purposes they are founded on as firm a stratum as could be secured, and are lined throughout with concrete. They are connected at the west end by a cross wall, thus enclosing the station area in, as it were, a water-tight compartment. At the west end of this area the space between the walls is filled in with a bed of concrete and invert of brick, and two-thirds of the whole area is inverted with concrete only to a depth of four feet. On this concrete invert the station and platform walls are founded. It may be mentioned that twice during the construction of these retaining walls the pressure of the water outside forced the masonry. and flooded the station areas. These mishaps, however, occurred when the works were in an unfinished state, and before the invert referred to had been put in. The walls are being surmounted by neat parapets of brick and ashlar.

THE GOODS SHED.

This magnificent structure, which is probably the finest of its class in Scotland, has just been finished. It is 400 feet long and 150 feet wide. The side walls, which rise to a height of 25 feet above the ground level, are built of brick, faced with compressed brick, and panelled. They rest on foundations of Portland cement concrete, which, in consequence of the ground being "forced," are of somewhat bulky proportions. These foundations are fully five feet deep and ten feet broad. No piles were used for the walls. The roof, which consists of three spans—two of 37 feet 6 inches each and one of 75 feet—is composite. The upper portion of the principals is constructed of pitch pine, while the struts and ties are of angle and T iron. Clear of the side walls, these principals rest on heavy malleable iron girders which run the whole length of the building, and these again are supported by cast-iron columns—18

in number—placed 40 feet apart from centres. The columns are set on massive blocks of concrete measuring 7 feet square and 9 feet deep. The roofs over the platforms and the several approaches are entirely glazed on Mr W. E. Rendle's patent system, and one is struck by the unusual brilliancy of the light and handsome appearance which it gives to the whole structure. This is caused by the absence of the ordinary sash bars, the panes of glass in this system merely overlapping each other. The area of glass in this roof will be about 70,000 square feet, and the magnificent goods sheds, which adjoin, are also glazed on this system, the area of glass being nearly 40,000 square feet. Mr Rendle's system being comparatively new, and possessing some peculiarities, may interest many of our readers. There is no putty used, and the glass is free to expand or contract in any direction when subject to heat or cold; vibration from wind, passing trains, &c., does not break the glass, as it is not bound in any way; repairs can be promptly effected, and the frequently recurring expense of reputtying and painting sash bars under the old system is entirely saved. The mode of fixing the glass is ingenious and very simple. Light bars or "purlins" of wood, or angle iron and wood combined, are fixed horizontally on the main principals of the roof at from 2 to 3 feet apart, and on these are fixed light zinc bars or "clips," which receive the glass. The top and bottom bars are of the form of hooks, and the central bars of S form. The rows of glass overlap each other within the central bars like slates, and, as already mentioned, the vertical joints, where sash bars would occur in the ordinary system, are made by simply overlapping the one pane on the other. This forms a perfectly watertight covering, and one very great advantage, which the ladies will appreciate, is that there is no "drip"—water formed by condensation escaping through the patent "clips." The system has been very extensively adopted for conservatories, winter gardens, weaving sheds, &c., where "drip" is most felt. It is worth noting as evidence of the desire of the Directors of the North British Railway Company to make our new station as comfortable and complete as possible, that, although all the contracts had been completed for the closing in of the roof on the ordinary system, they authorised Messrs Bennett & Co. to arrange for Mr Rendle's system. Another novelty, at least in Scotland, is Hawksley's patent treads, with which the stair leading to the east end of

the platforms has been fitted. The treads are of cast-iron, but filled on the upper surface with closely packed cubes of oak. The cross-cut ends of these form the actual foot tread, and project above the surface of the iron, which forms narrow spaces between the small wooden blocks. This forms a neat and safe foothold, which, in these days of high-heeled boots, is so important. These treads are remarkably durable, and have been extensively used for many years in the south, at the Metropolitan and other London stations. It would be well, and add much to the comfort of the public, if this example led to the more general adoption of these treads for railway stations and public buildings. Two loading platforms have been constructed running along two-thirds of the length of the shed, the Company intending to fill up the remaining length when the traffic necessitates the addition. Along these platforms and between each pair of columns are fixed the hydraulic cranes, constructed by Sir W. G. Armstrong & Co., of Newcastle. Twelve of these cranes have been erected. There being five lines of rails inside the shed, two traversers for the shifting of the waggons have been laid, and these are moved by hydraulics from the accumulator, which are afterwards described. All the waggons inside the shed will be drawn along by hydraulic power, capstans and snatch pillars having been distributed over the area of the building for that purpose. The shed has also been provided with four 13 feet diameter turn-tables, which have been laid down at the east end. In the building there are nine sliding gates. Three offices for the goods department officials are built at the east end. We may just add that this huge building took little more than twelve months to erect, and has been finished in a most substantial and complete manner. Mr John Waddell was the contractor. The whole arrangements of the goods shed and goods yard have been carefully devised and laid out with the view of handling a large traffic with the utmost expedition and great economy in working.

THE PASSENGER STATION.

During the construction of the Tay Bridge there were frequent surmises among those who were interested in the operations as to what sort of station accommodation was intended to be provided in connection with such a splendid undertaking, and it must be

confessed that for a long time the works in the Esplanade gave little indication of what design the buildings and platforms was to be. And now that the whole works may be said to be completed, it is scarcely credible that in so short a time such a thoroughly complete and substantial pile of buildings should have been drawn out, as it were, of a tract of treacherous mud. The building, which is placed in the centre of the platforms or between the "up and down" lines, is 380 feet long and 31 feet broad. The walls are founded on the 4 feet bed of concrete already referred to. They are composed principally of brick, but all the corners, door and window rybats, lintels, cills, and cornices, are of an extremely hard and beautifully grey stone from the West Plean quarries at Bannockburn. The bricks facing the platforms are what is termed "compressed," and the closeness with which they are jointed, combined with the fine polished face of the freestone courses alongside, give to the elevations of the building a remarkably clean and finished appearance. We may mention that grey stones for these facings could have been procured in the neighbourhood, the dressing or polishing of which could have been done by the contractor at one-half the expense which the Bannockburn stone has cost, but it seemed to be Mr Waddell's determination to use the finest stone obtainable. The "compressed" bricks were furnished by Messrs R. Small & Co., of Glencarse. The building consists of two storeys —one at the level of the platforms, and the other corresponding with the level of the roadway in the Esplanade. On the platform level are fixed—beginning at the east end—booking office, 46 ft. 6 in. × 14 ft.; stationmaster's office, telegraph office, parcel lift, luggage lift; room, 45 ft. × 26 ft., for left luggage; 1st class refreshment room, 2d and 3d class refreshment room; 1st class gentlemen's waiting room, 1st class ladies' waiting room; extensive lavatories and w.c.s; 2d and 3d class ladies' waiting room; lamp room, 24 ft. × 26 ft.; porters' room, hot water apartment, and public urinals and w.c.s. On the upper floor are fixed—beginning at the west end—large offices for the accommodation of the Company's local officials, two rooms for guards, additional offices, kitchen for refreshment rooms, dining hall 64 feet × 26 feet, luggage and parcel lifts, and two large parcel offices. Three spacious stone stair cases connect the platforms with the upper floor, and one of these—viz., the eastmost one, which is termed

the principal stair—is proposed to be used chiefly as an access to the dining hall. The upper floor is connected with the Esplanade, opposite the goods shed, by five roofed bridges or gangways, and these bridges can be approached from the street by carriages or carts. One of the bridges is set apart especially for parcels and luggage, and by an arrangement in the roof—which is made to overhang—passengers may leave carriages and enter the station, or packages may be removed to the platform from parcel vans and carriages, without being subjected to any drenching from rain. These gangway bridges, we may mention, are all closed in and roofed with glass. Two large clocks (about 4 feet diam.), made by Desh, of Glasgow, have been fixed against the north and south elevation. of the building, at a height of about 10 feet from the platform levels and can be seen with ease from the extreme ends of the platform, The roof over the platform consists principally of malleable-iron, in the shape of light horizontal and transverse lattice girders, riveted together and supported on massive cast-iron columns, fixed at about 48 feet from centre to centre. The design of the roof is unique ; and Dundee, we believe, is the first place where it has been introduced. This roof extends out from the gables of the building for a distance of about 400 feet at either end, and is carried along the north and south fronts of the building so as to completely cover the platforms. It is made so as to overlap the edge of the platforms on the lines of rails where the carriages will stand. It has been supplied and erected by Messrs Wight, Young, & Co., of Edinburgh. The glazing of the whole of these roofs has been undertaken by Mr Rendle, Westminster, whose patent we consider a great improvement on the old sash and astragal system. The panes are made to rest at their top and bottom edges in zinc perforated strips fixed on wooden purlins, and their sides simply overlap about an inch—no putty being introduced on the work. Mr Waddell, although contractor for the whole of the station (with the exception of the iron roof), sub-let the joiner work to Messrs Mackie & How, the plumber work to Mr David Brown, the plaster work to Mr Alex. M'Ritchie, the slater work to Mr Andrew Buttar, the iron work of gates and inside beams to Mr David Keay, and the ordinary glazier work of the building to Lindsay & Scott—all of Dundee. The painter work for the goods shed and the station has been entrusted to Mr

Forsyth, Edinburgh. We can only add that these gentlemen have conducted their several departments in a most satisfactory manner. The platform walls are 3000 feet long in all, and the whole area of the platform is equal to about 70,000 square feet, which has been laid with a concrete pavement—the patent of Mr Wilkinson, of Newcastle. This pavement is composed of a mixture of Portland cement and granite shivers reduced to very small proportions, and laid with an intermediate coating of coarse concrete on a bed of round gravel. The coping of the whole of the platforms, representing a superficies of 6000 feet, were from Mr William Langlands' quarry at Myreton. The drainage of the station is by gravitation —advantage having been taken of an 18-inch cast-iron pipe laid down by Mr Waddell in the Esplanade six years ago. This pipe extends 90 feet into the river at the level of low water of ordinary spring tides, and is supplied with several sets of valves, which are intended to be used in the very improbable event of any breakdown in the hydraulic pumps.

THE HYDRAULIC ACCUMULATOR BUILDINGS AND MACHINERY.

The only special feature about the construction of these buildings is the foundations, which were set down to suit the heavy machinery afterwards described. The ground, being of an extremely soft and yielding character, had to be excavated to a low depth, and strong piles and heavy masses of Portland cement concrete laid down. Special care had to be taken of the foundations in the accumulator tower in consequence of the enormous weight they had to support. Between these buildings and the station tunnels have been built for the purpose of containing the large piping in connection with the pumping machinery, and wells have also been sunk, where are deposited the pump and air vessels, with valves, belonging to the machinery. There are two boilers of the Cornish type, working to a pressure of 75 lbs. per square inch, for supplying steam to the horizontal pumping engine. The length of each is 25 ft., and the diam. 5 ft. 9 in. This engine is of the horizontal class, and is termed an "expansive acting steam pumping engine." It is capable of giving off 75 actual H.P. ; has two cylinders, each 14 inches diameter and 24 inch stroke ; with two double-acting force

pumps worked directly from the back of piston rods. The cylinders are steam jacketed and cleaded with oak, and fitted with double slide expansion valve gear to cut off at a third of the stroke. All the wrought-iron work is polished, the cast-iron portions of the engine being tastefully painted. This engine pumps the water into an accumulator, from which is derived a pressure equal to 700 lbs. per square inch, which is distributed to the different machines inside the goods shed and passenger station, and is also used for the purpose of pumping the water out of the tunnel. The number of cranes in the goods shed so worked is 12—two of which are 3-ton cranes, the remainder equal to 25 cwts. A very elaborate arrangement of valves and other gearing is placed at the foot of each crane, used for the purpose not only of hoisting goods, but also for slewing the loads. Throughout the area of the goods shed are fixed hydraulic capstans for hauling the railway waggons and working traversers and turntables. Each of these machines is capable of exerting a strain of 2000 lbs. upon the hauling rope or chain. The traversers referred to are adapted to carry a railway waggon of a gross load of 15 tons, and are laid down to suit a range of five lines of rails. Two hoists are fixed in the passenger station, which are used for the purpose of lifting and lowering passengers' luggage from the road level of the Esplanade to the level of the platforms below. These hoists are capable of lifting a load of two tons to a height of 14 feet 6 inches, and are each large enough to accommodate four platform barrows of the ordinary size. The pump for lifting the water out of the tunnel is double-acting, and is capable of discharging 60,000 gallons per hour. The whole of the steam and hydraulic machinery referred to has been supplied by Sir Wm. G. Armstrong & Co. of Newcastle-on-Tyne, and this is the first time that the principle involved in their construction has been applied to any railway depôt in Scotland. All the different parts of the machinery and apparatus have been thoroughly tested, and the result has been exceedingly satisfactory. The work of fitting up and the general superintendence of Sir William G. Armstrong's operations at this place have been entrusted to Mr Alfred F. Toovey, hydraulic engineer, who has carried through his department in a manner not only highly creditable to himself, but also to the eminent firm he represents.

THE TUNNEL—DIFFICULTIES OF CONSTRUCTION.

This important feature of the Tay Bridge works begins at the foot of South Union Street, and has occupied six years in construction. This period may be regarded as somewhat long, but it must be borne in mind that the work was of an exceedingly difficult character, and besides was carried on in one of the busiest thoroughfares of Dundee, viz., Dock Street, where, in addition to the contingencies arising from the heavy street traffic in such close proximity to the excavations, the works were subjected at every length of cutting to the pressure on one side of the water in the harbours and to the action of the tides inside the main sewer at the other. At the very outset circumstances occurred well calculated to cause dismay, and to raise doubts as to the ultimate successful completion of the works. In passing through Earl Grey's Dock it became necessary to construct a cofferdam 220 feet long, running diagonally across the Dock. The railway had to pass through the Dock at this point on a curve of ten chains radius, and for the old wall of the Dock, which lay exactly in the track, there fell to be substituted a new one. Within the cofferdam there has been built a wall of masonry fully 20 feet thick in the centre, the front portion of which forms the shipping quay, while the inside is the south wall of the Tunnel. This wall had to be so constructed that it should be able of itself to resist the pressure of a height of water in the Dock of 22 feet and at same time to keep that water from finding its way into the Tunnel. An effort was made to get the Harbour Trustees to run the water out of the Dock to allow this wall to be built, but there were objections to the proposal which the Trustees could not see their way to remove. The erection of the cofferdam was attended with great risk. Many of the piles had to be placed on the solid rock, and, in order to resist the pressure of the great body of water in Earl Grey Dock, it became necessary to load the dam with stones to the weight of nearly 250 tons. It was also very strongly braced back upon the street. Notwithstanding these unusual precautions, everything did not go quite as merrily as a marriage bell. No sooner had the new dock wall been finished and connected with the old masonry and the removal of the cofferdam commenced than the water burst through with such force as to completely undermine part of the enormously strong building we

have described and flood the tunnel in a few minutes. By the prompt measures employed and the aid of exceedingly powerful pumps the water was shortly afterwards expelled, the leak was stopped, and the wall repaired, and this portion of the structure is now considered as strong as any of the other parts which were never touched by water. Another source of trouble arose from the main sewer of the town, of which mention has been made, extending from West Dock Street to the foot of Castle Street, lying exactly in the line of railway. It fell to be diverted and connected with the old sewer near the Music Hall. The sewer had to be continually flushed with dock water, and there was also a continual pressure of surface water, and the junction was only effected after many months of constant labour. The main sewer at the Custom House had also to be treated similarly, and caused quite as much annoyance and delay. Along the track of the tunnel there was also the 18 in. gas main, and in removing it farther north the contractor had to put down a length of pipe of nearly 1500 feet. The flushing connections, too, which existed between the main sewer and King William and Earl Grey Docks were cut off by the tunnel, and provision had to be made for the substi tution of means by which this flushing could be continued. For this purpose rectangular cast-iron syphon tubes were passed below the tunnel, first at Earl Grey and afterwards at King William Docks, and these tubes, which were furnished with valves of superior description, have been found to act with the greatest efficiency. Another syphon had to be put in at West Dock Street, which acts as an overflow for the storm water in the main sewer near that point. After the tunnel had been all but finished, it was found that this main sewer had to be dealt with further, and it turned out that before the whole works could be completed and the junction with the Caledonian line effected, another diversion more expensive and more hazardous than those mentioned had to be carried out. This diversion was not contemplated in the original design, as it was considered that the sewer was sufficiently distant from the line of operations at the open cutting as to admit of the walls being built without interfering with the drainage. But until the matter had been fully investigated, the tunnel works were stopped for six months. When operations were resumed it was found that the tunnel at the east end required to be moved 9 feet

farther north, which again threw the main sewer into the track of the railway. This time, however, the sewer had to be temporarily provided for, and it was therefore carried along the face of the south wall in the open cutting in two four feet iron pipes supported on brick piers. The length of this piping was 1200 feet. Two sets of valves made by the contractor were put on at each end of the diversion where the present sewer was broken into, and these had to be supported by thick walls of brick built in cement in the centre of the tunnel, so as to withstand the tidal pressure in the sewer. The difficulty in this diversion was, that while the sewer required to fall on a gradient of 1 in 400, the side walls of the railway rose in horizontal steps on a gradient of 1 in 60. This rise of 1 in 60, however, enabled the walls to clear the sewer at the length stated, after which no other danger presented itself. The new sewer is now a portion of the north wall of the open cutting, is 7 feet high and 5 feet broad inside, and is entirely built of brick in cement. So soon as the side walls of the open cutting rose above the level of the sewer, and the junction openings built up, the iron pipes and valves were removed, and the other works proceeded with. After thus narrating some of the difficulties which had to be encountered by the contractor in executing the tunnel, and having regard also to the magnitude of the work itself, and to the admirable manner in which it has been completed, it will notcreate surprise that its construction has extended over so long a period.

DETAILS OF CONSTRUCTION.

The tunnel is 1880 feet in length, and the open cutting connecting the tunnel with the Caledonion line 1020 feet in length. The north and south walls are entirely of brick, excepting a small piece of the south wall at Earl Grey's Dock, which, as already stated, is of solid masonry. The depth of excavation has been twenty-two feet from the surface of the street, and the width over all nearly 40 feet. The south wall is within ten feet of the water in Earl Grey and King William Docks throughout almost its entire length, and is built hard against the masonry of the harbour quays. The carrying of the works so near the water was not unattended by danger, and the contractor is satisfied that had the harbour walls

been less substantial or less efficiently built there would have been bursts of a serious character. The result has been exceedingly satisfactory. Although the foundations of the tunnel are in many parts below the foundations of the old walls there has been no flooding whatever indeed, the south wall has never from the beginning ever shown the least appearance of leakage. It may not be out of place here, in referring to the admirable manner in which these Harbour walls have been built, and to the service they have rendered in the construction of the tunnel, to state that we understand they were put down under the special supervision of Mr James Leslie, C.E., of Edinburgh, the Engineer of the Dundee Water Works. It must be gratifying to that gentleman to learn that the work he constructed so many years ago has stood so well the protracted test to which it has been subjected. Concrete has been placed in the bottom of the excavations to the depth of nearly two feet, but the side walls are founded upon the stratum below. The brick portion of the walls rests upon ashlar skewbacks forming the springing of the invert, and these skewbacks are laid on rubble masonry, built in the very best hydraulic lime. The masonry on an average is fully three and a half feet deep. The design for the brick walls is somewhat similar to that adopted in the Metropolitan railways, and consists of piers placed eight feet from centre to centre, the intervening spaces being filled in with battered retaining walls. The retaining walls are also curved, to give additional strength to the structure, and [illegible] concrete is laid to a thickness of about two feet, and is carried along over the whole length of the tunnel. The [illegible] arched with a brick arch, 9 inches thick, resting upon a layer of concrete averaging 2 feet thick. On the top of the brick [illegible] a [illegible] about 18 inches in diameter, which is used as the [illegible] of the tunnel. At a depth of nearly four feet [illegible] the [illegible] of the street the walls finish in [illegible] ashlar [illegible] supports of the roof beams, which are placed [illegible] and are [illegible] of cast-iron, [illegible] weighing [illegible]. Where the tunnel crosses the [illegible] Street malleable iron [illegible] are introduced, thereby greatly [illegible] the [illegible] of [illegible] [illegible] [illegible]

malleable beams. Over all the beams there are arches forming the roof of the tunnel, and over these again is laid a coating of concrete and asphalte, quite excluding the admission of water. The causeWaying of the street is carried immediately above the asphalte coating, the present railway tramway being right over the roof of the tunnel. Internally the width is 25 feet, and the height from the top of the invert to the underside of the beams of the roof 16 feet 3 inches, the distance from the level of the rails to the underside of the beams being 13½ feet. The tunnel opens out close to the East Dock Street Station, and the railway is carried to the level of the Caledonian line on a gradient of 1 in 60, the rails being laid between curved retaining walls, which are surmounted by a parapet of brickwork and ashlar. The junction with the Caledonian line is made at the first level crossing. The line is double throughout.

The whole of the Railway and Tunnel works, have been constructed by Mr John Waddell, of Edinburgh, and reflect credit on that gentleman's well-known abilities as the first railway contractor in Scotland. The manager of the works has been the contractor's brother, Mr David Waddell, to whom, along with the Inspector of Works, Mr David Gemmell, much of the success of the operations is due.

The engineering department has been undertaken by the contractor's staff at Dundee, at the head of which is Mr George S. Hird, C.E., who has shown great ability and resources, along with a degree of firmness and tact, which mark him out for future eminence in his profession.

OPENING PROCEEDINGS,

On Friday, 31st May 1878.

[On Friday, 31st May 1878, the Tay Bridge was opened in presence of representatives of the authorities of the different counties and burghs of Scotland, the high officials connected with the leading railways of the kingdom, a numerous attendance of gentlemen identified with the commercial and manufacturing interests, and a large assemblage of the citizens of Dundee and surrounding country. It was at one time expected that the Queen or some member of the Royal Family would be present at the formal opening, but having regard to the nature of the works it was found impossible to say definitely when the bridge could be ready for traffic. The Directors were anxious that it should be made available at the earliest possible moment, in order that the Company might reap the benefit of the summer traffic; and consequently, when the whole of the works were inspected by the Board of Trade authorities and declared ready for use, the arrangements for the opening were matured with the greatest despatch. Accordingly there was no opportunity of having a demonstration on a large scale. Although the event would no doubt have been invested with wider interest had there been the presence of Royalty, yet all who had the opportunity of witnessing the ceremony must have experienced that gratification which proceeds from the happy and successful accomplishment of any great work. The weather, so important an element in any open-air celebration, was simply magnificent, the sun shining out brilliantly, and there being scarcely a cloud in the sky.

Invitations were issued to over 600 gentlemen, and those resident south of the Tay were conveyed to the bridge by special train leaving Edinburgh at 9.35 A.M. Those belonging to Dundee and the north were conveyed by steamer to Tayport. The Auld Reekie was placed at the disposal of the party, and left the Craig Pier, Dundee, shortly after eleven o'clock A.M. After a pleasant sail, which was enlivened by the music of the Band of the Camperdown Linen Works, under the leadership of Mr Andrew Johnston, Tayport, was reached, and there a train was in waiting, composed of a number of first-class carriages. Only a few minutes elapsed before everything was in readiness, and about half-past eleven o'clock the special was on its way to Leuchars. The train from Edinburgh, which had stopped at Kirkcaldy, Thornton, Ladybank, and Cupar to take up gentlemen who had been invited, had arrived a few minutes earlier. The trains

having been united, the journey to Dundee was at once commenced. The run to the south end of the bridge only occupied about ten minutes. At the entrance to the bridge many spectators from Newport were in waiting, and as the train entered on the structure hearty cheers were raised. Of those who were in the train not a few had never before crossed the Tay, and the sudden view of its expansive waters, with the magnificent landscapes towards the Carse of Gowrie on the west, and with Dundee and its suburbs lying panoramic like to the north, excited lively admiration. The train, which was drawn by the powerful locomotive "Lochee," proceeded slowly across the bridge. Vibration was scarcely perceptible, and the speed was purposely reduced in order that the best possible view of the river might be afforded. The Esplanade and the Magdalen Green presented an animated scene. Considerable crowds had assembled on the Green, and the Esplanade was lined from end to end. As the train crossed the bow string at the Magdalen Point loud and prolonged cheers were raised, which were responded to by the occupants of the train, who waved their hats and handkerchiefs. About twenty minutes to one o'clock the train drew up at the platform on the north side of the station. Here Provost Robertson, the Magistrates, and several members of the Town Council were in waiting, and when ex-Provost Cox and Mr Stirling of Kippendavie alighted from their carriage they were cordially welcomed by the Provost. At the station a very large number of people had collected, many of those present being ladies. Provost Robertson, with ex-Provost Cox and Mr Stirling, ascended one of the staircases, the band of the 1st Forfarshire Volunteers, under Mr Warren, meanwhile playing "See the Conquering Hero Comes," and the formal opening of the bridge was thus declared.

THE BRIDGE DECLARED OPEN.

Provost ROBERTSON—Mr Cox, will you allow me the pleasure, in the name of the Magistrates and Town Council of Dundee, to give a hearty welcome to Mr Stirling and his co-Directors of the North British Railway Company and of the Tay Bridge undertaking, together with all their friends connected with other railways throughout the United Kingdom, and also along with them their friends from all parts of the country, who have done us the honour to come here to-day to celebrate the opening of this grand undertaking—the Tay Bridge, which now spans the Tay and connects the great county and kingdom of Fife with that of Forfar. I assure you, gentlemen, it affords me great pleasure indeed to have the high honour of giving you a right hearty welcome into our royal burgh to-day, and I am sure it must be gratifying to the whole of you, as it is to myself and to my fellow-Magistrates and Council, that you have had such a delightful day to see the inauguration of this grand work—the spanning of the Tay. I hope you have had a comfortable journey over that noble bridge, and the effect of the example set by so many gentlemen with so extensive experience—world-wide experience I may say—testifying their confidence in the stability of the structure, will be that we shall have the pleasure of welcoming thousands upon thousands of strangers to our good

North British Railway Company, in testimony of their high appreciation of the ability and perseverance by which he has for years promoted the erection of the railway bridge across the Tay, and for his important services in developing a system of railway commu[illegible]tion calculated to be of such vast importance not only to the trade [illegible]ctures of Dundee, but to the ever-increasing benefit of the north[illegible] and the through traffic of the country ge

The Council therefore, and having t before them, did, and hereby do, as this date, duly and lawfully create and and John Stirling, Esq., as Free Burge of the First Class, and did, and herel sundry liberties, privileges, and imm always conform to, and in terms of t declaring that the said Thomas Boucl of these privileges, become solemnly b incumbent by law on the true and faithf Council authorised the Provost and Tc record of the creation and admission o Stirling as burgesses of said burgh acc authorised this minute of admission to b reading in Council, and remitted to the as to the presentation of the certificat Thomas Bouch and John Stirling.

The business for which the meeting proceedings terminated.

When all had been comfortably seated

Provost ROBERTSON rose to give effect He said—Mr Chairman and gentleme important business for which we are ass a hearty luncheon—I am sure you wi interruption in our business to-day, and for which I make this interruption I (Applause.) At a meeting of Town C purpose of disposing of some prelimina effect to the opening ceremony which satisfaction to-day, it was unanimously [illegible] upon their records the sense of the high value and esteem in which they regard our worthy Chairman, ex-Provost Cox—(applause)—and also to testify by that minute their sense of the valuable services which he has been able to render in the promotion and ultimate completion and now the opening of the Tay Bridge. (Applause.) The Town Council of Dundee would not be doing their duty did they fail to place upon their records, that it may go down to posterity, the name of Mr Cox as having been associated and identified so prominently with the construction of the Tay Bridge. The Town Council farther resolved to confer two honours upon gentlemen well worthy of receiving these honours, I am sure. I am sorry that one of the gentlemen who was to receive the honour at my hand in name of the Magistrates and Town Council to-day has been unable to be present with us, but I am delighted to have on my left hand here the hon. Chairman of the North British Railway, Mr Stirling of Kippendavie. (Applause.) It has been the unanimous resolve of the Town Council to confer upon Mr Stirling the freedom of the ancient and Royal burgh of Dundee. (Applause.) Mr Stirling knows Dundee so well that he may not think it a very high or very great honour, but I am sure that you, gentlemen, together with Mr Stirling himself, cannot fail to know that it is the highest honour the Magistracy and Council of Dundee have in their power to bestow. (Applause.) I am sure by their resolution to bestow this honour upon Mr Stirling they have well

considered the importance of the position that Mr Stirling for many years has occupied, not only in connection with the North British Railway Company, but also with other important sections of the railway systems in Scotland; and it is known to you more, I daresay, than it is or can be to me, how deeply Mr Stirling has been connected with the railway world for many years. With these remarks I will now call upon the Town Clerk to read to you the presentation made by the Town Council of the freedom of the burgh to Mr Stirling. (Applause.)

Mr HAY, Town Clerk, then read the burgess ticket, engraved on vellum, admitting Mr Stirling as a free burgess in testimony of their high appreciation of his ability and perseverance in promoting the erection of the Tay Bridge and his important services in developing the railway system, calculated to be of such benefit to Dundee and the northern district of Scotland—(applause)—and declaring that Mr Stirling by such admission should be bound to discharge all the duties incumbent on a loyal citizen of Dundee. (Loud applause.) The deed was signed by the Provost and Town Clerk, and had the seal of the town attached.

The PROVOST—It would be quite out of place in me to pass any eulogium upon Mr Stirling in the presence of so many gentlemen whose names have been associated with the railway system in all parts of the kingdom. I am sure you all agree with me that Mr Stirling is highly deserving of this honour which we now propose to confer upon him. I have only to express our sincere desire that Mr Stirling may be long preserved in health and strength to exert himself as he has done in the past for the promotion of all that tends to the prosperity of that noble system of railway of which he is now at the head, and that the opening of the Tay Bridge to-day will in a large measure tend to the development of the system, and secure through traffic and communication which we have not hitherto enjoyed. (Applause.) I have now the honour, in name of the Magistrates and Town Council of Dundee, to present to you, Mr Stirling, the freedom of this ancient and and Royal burgh, and to give you a right hearty welcome as a burgess of this good town. (Applause.) Before Mr Stirling replies, I have just to say that the Council also unanimously resolved to bestow the freedom of this burgh upon Mr Thomas Bouch, Civil Engineer, Edinburgh—(cheers)—the originator, the promoter, and the engineer of the structure. I only regret we have not Mr Bouch with us to receive the presentation, and I will ask Mr Stirling to be kind enough to communicate to Mr Bouch at the earliest possible moment that we will wait his convenience to receive it at our hands. (Applause.)

Mr STIRLING, in replying, said—Provost, Magistrates, and Town Council of Dundee, I rise to return you my most sincere thanks for the honour which you have conferred upon me, and I have to assure you that I don't look upon it in the trivial light in which the Provost seems to think I will regard it. (Applause.) I appreciate it very highly indeed as a great honour, and I do so all the more as it was perfectly unsolicited by me. I had not the slightest expectation when I came here yesterday that I would have to return you my thanks for such an honour. My connection with Dundee has always been of the most agreeable character, and when we have had to come in contact with members of the public bodies we have always worked harmoniously and comfortably together. (Applause.) Of course we have had different views on some subjects, but we have never departed without making arrangements on a fair and satisfactory basis, and if anything will increase my desire to remain on that footing with this municipality, it is the proud position in which you have placed me this day. (Applause.) Gentlemen, I will only add that if I can do anything to promote the prosperity of Dundee I shall be glad to do it. (Applause.)

Mr G. B. WIELAND, who was warmly received, said:—No one, I am sure, will more regret his absence on this interesting occasion than Mr

Bouch himself. I need hardly say that, like Mr Stirling, Mr Bouch had no conception that the Town of Dundee would be likely to confer upon him so signal an honour as they have been graciously pleased to bestow. Many of you now present know, and all of you can appreciate, the great anxiety that a person of Mr Bouch's intense energy must have endured during the last few months in his constant efforts to get the Bridge and railways opened at the earliest possible moment; and so soon as he saw this practically accomplished he left for the south of England with the view of recruiting his health, which stood much in need of it. I fear, however, that he is hardly likely to pay himself that attention which we should all wish him to do, as I have reason to believe that his active brain is already busy at work completing the minutest details in connection with the construction of the Forth Bridge—(applause)—his greater work, and which I may tell you he recently informed me he hoped and expected to see completed in little more than three years from this date. (Loud applause.)

The ceremony in connection with the presentation of the freedom having been concluded,

THE BANQUET

Was commenced at 2 o'clock. Ex-Provost Cox, Chairman of the Tay Bridge undertaking, presided, supported on the right and left by the Right Hon. the Earl of Elgin and Sir James Falshaw, Bart., the Croupier being Mr John Stirling of Kippendavie, Chairman of the North British Railway Company, who was supported on the right and left by Provost Robertson and Mr Hay, Town Clerk. The following is a list of the invitations issued:—

Edinburgh.—The Right Hon. Thomas J. Boyd, Lord Provost of Edinburgh; Mr William Skinner, Town Clerk; Mr Alexander Harris, Depute-Clerk; Mr John Smith, Dean of Guild; Mr John Wilson, Treasurer; Mr Robert Legget, Convener of the Trades; Bailies Thomas Rowatt, James Colston, John Tawse, Robert Cranston, Wm. Anderson, and George Roberts; Mr Robert Paterson, City Assessor; Mr Duncan M'Laren, M.P.; Mr James Cowan, M.P.; Mr John Warrack, Chairman Chamber of Commerce; Mr David Dickson, Master of Merchant Company; Mr William Bain, City of Glasgow Bank; Mr W. J. Duncan, National Bank; Mr J. S. Fleming, Royal Bank; The Duke of Buccleuch of Queensberry, Lord-Lieutenant of Midlothian; Mr Archibald Davidson, Sheriff of Midlothian; Mr Frederick Hallard, Sheriff-Substitute; Mr Hubert Hamilton, do.; The Right Hon. Lyon Playfair, M.P. for Universities of Edinburgh and St Andrews.

Leith.—Mr John Henderson, Provost of Leith; Mr Wm. H. Couper, Town Clerk; Mr A. Grant, M.P.; Mr Charles Stein, Chairman Chamber of Commerce.

Glasgow.—The Hon. William Collins, Lord Provost of Glasgow; Mr J. D. Marwick, LL.D., Town Clerk; Mr J. C. Bolton, Chairman Chamber of Commerce; Sir James Watson, Chairman Merchants' House; Mr George Reith, Clyde Navigation; Mr James Deas, do.; Mr R. S. Stronach, City of Glasgow Bank.

The Chairman of South of Scotland Chamber of Commerce, Hawick.

Aberdeen.—Mr George Jamieson, Lord Provost; Mr Wm. Gordon, Town Clerk; Chairman of the Chamber of Commerce.

Fifeshire.—Mr James A. Crichton, Sheriff of Fifeshire; Mr Andrew B. Bell, Sheriff-Substitute; Mr William Lamond, Sheriff-Substitute; Sir Robert Anstruther, Bart., M.P. and Lord-Lieutenant; Sir George Campbell, M.P. for Kirkcaldy Burghs; Mr Edward Ellice, M.P. for St Andrews Burghs; Mr H. Campbell Bannerman, M.P. for Dunfermline.

Forfarshire.—Mr F. L. Maitland Heriot, Sheriff of Forfarshire; Mr Alexander Robertson B.A., Sheriff-Substitute; Mr John Cheyne, B.A., Sheriff-Substitute; Mr James William Barclay, M.P. for County; the Earl of Strathmore, Lord-Lieutenant; the Right Hon. W. E. Baxter, M.P. for Montrose Burghs.

Dundee.—Mr William Robertson, Provost of Dundee; Mr William Hay, Town Clerk; Mr H. B. Fergusson, Chairman Chamber of Commerce; Bailies John Robertson, William Cleghorn, Duncan Macdonald, James Thomson, James Allan, and James Low; Dean of Guild Edward; Treasurer Ogilvie; Councillors John Adamson, Andrew G. Kidd, William Brownlee, James Perrie, William Blair, John Sutherland, James Cowan, Robert Laing, David A. Bruce, W. P. Mitchell, George H. Nicoll, Frank Henderson, William Philip, jun., William Thomson, James Gentle, John Anderson, Hugh Ballingall, Charles C. Maxwell, and Alexander H. Moncur; Mr W. A. Fleming, Town Chamberlain; Mr William Alexander, Town Architect; Mr John Leadbetter, Mr Robert Milne; Mr James Watson, C.E., engineer and manager, Water Commission; Mr Thomas Thornton, Clerk, Police Commission; Mr D. Farquharson, Treasurer, do.; Mr W. Mackison, Surveyor, do.; Mr D.

Dewar, Superintendent, do.; Mr G. D. M'Dougald, Analyst, do.; Messrs James Mitchell, A. J. Warden, A. W. Fairweather, J. G. Whitelaw, Alex. Duncan, David Anderson, John Black, Wm. Fyffe—Gas Commissioners; Mr James Matthew, Treasurer, Gas Commission; Mr Boyd M. Macrae, Manager, do.; Mr W. R. M'Kelvie, Superintendent under Burial Grounds Act; Mr Thomas Buchan, Chairman, Parochial Board; the Rev. Dr Watson, the Rev. Mr Somerville, Dr James Arrott, Dr J. B. Baxter, Mr John Kennedy, Mr Wm. Y B. Martin, Mr John Henderson, Mr J. D. Cox, Mr J. G. Orchar, Mr D. Jobson, jun.—members of the Free Library Committee; Mr John Maclauchlan, Chief Librarian; Mr W. O. Dalgleish, Mr Alex. Mathewson, Mr George Halley, Mr James Luke, Mr James Shaw, Mr James Mitchell, Mr Peter Anderson, Mr A. S. Drummond, Mr W. B. Scott, Mr George Welch, the Earl of Camperdown, Mr P. H. Thoms, Mr Robert M'Gavin, Mr Alexander Henderson, Mr David Alexander, Mr Thomas Couper, Mr John Machan, Mr W. S. Croudace, Mr David Bruce, Mr James Millar, Mr William Nicoll, Mr Thomas S. Ross, and Mr Wm. G. Thomson—Harbour Trustees; Mr Wm. Thoms, Harbour Clerk; Mr James Watson, Harbour Treasurer; Mr D. Cunningham, Harbour Engineer; Mr J. J. Weinberg, Mr W. Gibson, Mr Alex. Scott, Mr Alex. Gilroy, jun., Mr John Rhind, Mr O. G. Miller, and Mr Andrew Lowson (Arbroath)—Directors, Chamber of Commerce; Mr Robert Sturrock, Secretary and Treasurer, do.; Mr G. Carmichael, Mr A. Maxwell, Mr D. Cargill, Mr P. E. Walker, Mr W. W. Renny; Mr Thomas Smith, Deputy Chairman, Savings Bank; Mr James Yeaman, M.P.; Mr Edward Jenkins, M.P.

Burgh Representatives.—Mr George Shield, Provost of Arbroath; Mr W. K. Macdonald, Town Clerk, do.; Mr John Milne, Provost of Montrose; Mr George C. Myers, Town Clerk, do.; Mr John Lowson, jun., Provost of Forfar; Mr James Taylor, Town Clerk, do.; Mr Charles Will, Provost of Brechin; Mr James L. Gordon, Town Clerk, do.; Mr James Christian, Chief Magistrate, Stonehaven; Mr David Carr, Town Clerk, do.; Mr Thomas Richardson, Lord Provost of Perth; Mr William MacLeish, Town Clerk, do.; Mr David M'Farlane, Chief Magistrate of Coupar Angus; Mr James Watson, Clerk to Commissioners, do.; Mr Walter T. Milton, Provost of St Andrews; Mr Stuart Grace, Town Clerk, do.; Mr Chas. W. Tennent, Provost of Cupar; Mr W. Duncan, Town Clerk, do.; Mr Patrick D. Swan, Provost of Kirkcaldy; Mr Alexander Gibson, Joint Town Clerk, do.; Mr W. R. Spears, Joint Town Clerk, do.; Mr William Robertson, Provost of Burntisland; Mr Thomas A. Wallace, Town Clerk, do.; Mr James Walls, Provost of Dunfermline; Mr John Landale, Town Clerk, do.; Mr William Bailey, Chief Magistrate of Alloa; Mr Robert Buchanan, Clerk to Commissioners, do.; Mr George Christie, Provost of Stirling; Mr Thomas L. Galbraith, Town Clerk, do.; Mr Abram Lyall, Provost of Greenock; Mr John K. Gray, Town Clerk, do.; Mr David Murray, Provost of Paisley; Mr William Hodge, Joint Town Clerk, do.; Mr David Young, Joint Town Clerk, do.; Mr F. Martin, Joint Town Clerk, do.; Mr James Brand, Provost of Dunbar; Mr Charles Notman, Town Clerk, do.; Mr Thomas Darling, Mayor of Berwick; Mr Robert Douglas, Town Clerk, do.; Mr David Stevenson, Provost of Haddington; Mr J. Stobie, Town Clerk, do.; Mr James Johnstone, Chief Magistrate of Kelso; Mr Charles A. Hutchison, Clerk to Commissioners, do.; Mr Andrew Easton, Provost of Jedburgh; Mr James Steedman, Town Clerk, do.; Mr Robert Ewan, Provost of Hawick; Mr Thos. Purdon, Town Clerk, do.; Mr Henry S. Anderson, Provost of Selkirk; Mr Peter Rodger, Joint Town Clerk, do.; Mr George Rodger, Joint Town Clerk, do.; Mr John Hall, Provost of Galashiels; Mr Robert Stewart, Town Clerk, do.; Mr Andrew Green, Provost of Peebles; Mr J. D. Bathgate, Town Clerk, do.; Mr John C. Forrest, Provost of Hamilton; Mr Edward P. Dykes, Town Clerk, do.; Mr James Johnston, Chief Magistrate of Bathgate; Mr Charles Allan, Clerk to Commissioners, do.; Mr Archibald Corrie, Provost of Airdrie; Mr Thomas A. Macfarlane, Town Clerk, do.; Mr Thomas Wood, Provost of Portobello; Mr Robert P. Stevenson, Town Clerk, do.; Mr George Laurie, Provost of Musselburgh; Mr Thomas Lees, Town Clerk, do.; Mr Stephen Yonder, Clerk to Commissioners, Leven; Mr John Stuart, Chief Magistrate of Helensburgh; Mr George Maclachlan, Clerk to Commissioners, do.; Mr William H. Anderson, Provost of Anstruther Easter; Mr Andrew Wilson, Chief Magistrate of Anstruther Wester; Mr James Tosh, Provost of Pittenweem; Mr John Bowman, Town Clerk, do.; Mr Francis Honeyman, Provost of Auchtermuchty; Mr H. W. Walker, Joint Town Clerk, do.; Mr Archibald Walker, do., do.; Mr John Hay, Provost of Inverkeithing; Mr H. Grigor, Town Clerk, do.; Mr Wm. Smith, Provost of Kinghorn; Mr Wm. M. Don, Town Clerk, do.; Mr John Russell, Provost of Falkirk; Mr Robert Henderson, Town Clerk, do.; Mr Thomas Steele, Provost of Ayr; Mr John Pollock, Town Clerk, do.; Mr Peter Sturrock, Provost of Kilmarnock; Mr Alexander Hamilton, Joint Town Clerk, do.; Mr James Hamilton, do., do.; Mr Thomas F. Smith, Provost of Dumfries; Mr William Martin, Town Clerk, do.; the Mayor of Carlisle; Mr John Nicholson, Provost of Annan; Mr Alex. Downie, Town Clerk, do.; Dr Brown of Pinkerton, Provost of Crail; Mr David Rogerson, Provost of Dumbarton; Mr Alexander Allan, Joint Town Clerk, do.; Mr Alexander Denny, do., do.; Mr David Watt, Provost of Dysart; Mr Thomas Dow, Town Clerk, do.; Mr Adam Dawson, Provost of Linlithgow; Mr Robert R. Glen, Town Clerk, do.; Mr Andrew Landale, Chief Magistrate of Lochgelly; Mr John Small, Clerk to Commissioners, do.; Mr Sommerville, the Provost of Port-Glasgow; Mr T. R. Maclelland, Town Clerk, do.

Railway Representatives.—North Eastern—Mr George Leeman, M.P.; Mr C. N. Wilkinson, Mr Henry Tennant, Mr Thomas Harrison, C.E.; Mr Fraser, Mr Alex. Christison. *Great Northern*—Col. the Hon. Octavius Duncombe, Right Hon. Lord Colville, K.T.; Mr Alexander Forbes, Mr Henry Oakley, Mr John Ashley, Mr F. P. Cockshott. *Midland*—Mr Edward Shipley Ellis, Mr Matthew W. Thompson, Mr James Williams, Mr James Allport, Mr W. L. Newcombe, Mr E. M. Needham, Mr J. P. Javing. *London and North*

Western—Mr Richard Moon, Mr Stephen Reay, Mr G. Findlay, Mr T. Kay, Mr G. P. Neele. *Lancashire and Yorkshire*—Mr Thomas Barnes, Mr Joshua Radcliffe, Mr J. H. Stafford, Mr William Thorley, Mr T. Collin, Mr John Maddock. *Great Western*—Sir Daniel Gooch, Bart., M.P.; Sir Alex. Wood, Mr Fred. G. Saunders, Mr James Grierson, Mr John Grant, Mr G. N. Tyrrell. *Great Eastern*—Mr Charles H. Parkes, Lord Claud John Hamilton, M.P.; Mr J. Hadfield, Mr S. Swarbrick, Mr W. Birt, Mr J. Robertson. *Maryport and Carlisle*—Sir Wilfrid Lawson, Bart., M.P.; Mr Robert Ritson, Mr John Addison. *Manchester, Sheffield, and Lincoln*—Sir E. W. Watkin, M.P.; Mr William Fenton, Mr Edward Ross, Mr R. G. Underdown, Mr Charles Scotter, Mr W. Bradley. *London and South Western*—Hon. R. H. Dutton, Mr W. S. Portal, Mr Fred. Clarke, Mr Archibald Scott, Mr J. T. Haddow, Mr E. W. Verrinder. *Carlisle and Silloth Bay*—Mr P. J. Dixon, Mr R. S. Ferguson, Mr John Laven. *Cockermouth, K. & P.*—Mr Isaac Fletcher, M.P.; Mr John Jameson, Mr Peter Thompson. *Furness*—Duke of Devonshire, K.G.; Sir James Ramsden, Mr Henry Cook. *Port-Carlisle*—Mr J. Nanson. *Chester Lines Committee*—W. English. *London, Brighton, and S.C.*—Mr Samuel Laing, M.P., Mr Jonas Levy, Mr Allen Sarle, Mr J. P. Knight, Mr G. W. Stamforth. *London, Chatham, and Dover*—James S. Forbes, Sir S. H. Waterlow, Bart., M.P., Mr John Morgan, Mr M. Harris, Mr C. H. Chapman. *South Eastern*—Hon. James Byng, Mr John Shaw, Mr J. Light, Mr J. G. Harris. *East Coast Companies*—Mr John Marsters. *Caledonian*—Mr Thomas Hill, Mr A. Gibson, Mr James Smithells, Mr James Thompson, Mr Henry Ward, Mr Robert Small, Mr James Whitton. *Glasgow and South Western*—Sir James Lumsden, Mr Peter Clouston, Mr John Morton, Mr W. J. Wainwright, Mr John Mathieson, Mr David Dickie. *Blane Valley*—Mr R. S. Muir, Mr James Keyden. *Kelvin Valley*—Mr Hugh Bartholomew, Mr Henry Lamond. *Edinburgh and Bathgate*—Mr Robert Hutchison, Mr Alexander Jamieson, C.A. *Forth and Clyde Junction*—Mr John M'Gavin, Mr Alexander Wilson, Mr Robert Young. *Greenock and Wemyss Bay*—Mr James Stewart, Colonel Buchanan. *Great North of Scotland*—Mr William Leslie, Mr James Crombie, Mr W. B. Ferguson, Mr Robert Milne, Mr A. M. Ross, Mr F. Morrison. *Highland*—Mr Alexander Matheson, M.P., Hon. Thomas Charles Bruce, M.P., Mr Andrew Dougall, Mr Thomas M'Kay, Mr George K. Ellis, Mr Thomas Robertson. *City Union*—Mr Q. Y. Lawson. *Glasgow and Paisley Jt. Lines*—A. Cowan. *North British Railway*—Mr John Stirling, Chairman; Mr John Beaumont; Right Hon. W. P. Adam, M.P.; Mr James Cox, Chairman Tay Bridge Undertaking; Sir James Falshaw, Bart.; Mr Peter Garnett, Mr Henry Grierson, Mr George Harrison, Mr Alexander Harvie; Sir William Miller, Bart.; Mr Wm. Muir, Mr George Robertson, Mr H. J. Trotter, Mr Robert Young, Mr John Walker, Mr G. B. Wieland, Mr James Ferguson, Mr James Macdonald, Mr James M'Laren, Mr Adam Johnstone, Mr D. M'Dougall, Mr George Simpson, Mr D. Anderson, Mr D. Drummond, Mr A. Robertson, jun., Mr James Bell, Mr A. F. Clement, Mr Robert Bell, Mr James Bell, jun., Mr Charles Boyd, Mr James Carswell, Mr A. Rutherford, Mr James Bruce, Mr D. Deuchars, Mr John Hay, Mr A. B. Scott, Mr Robert Darling, Mr Peter Wood, Mr George F. Barbour; Sir G. Graham Montgomery, Bart., M.P.; Mr Archibald Orr Ewing, M.P.; Mr Walter Mackenzie, Mr J. Wyllie Guild. *Tay Bridge Railway*—Mr G. W. Clark. *Arbroath and Montrose Railway*—Mr Francis Aberdein, Colonel Macdonald, Mr William Mitchell, Mr Hercules Scott. *Newport Railway*—Mr Harry Walker, Mr James Henderson, Admiral Maitland Dougall, Mr Peter Christie.

General Invitations.—Duke of Sutherland, Earl of Panmure, Earl of Southesk, Lord Kinnaird, Lord Wharncliffe, Lord Rosslyn, Lord Airlie, Lord Balfour of Burleigh, Lord Polwarth, Sir John Don Wauchope, Bart., Sir John Ogilvy, Sir George Kinloch, Mr John Waddell, Mr Edgar Gilkes, Mr William Gill, Mr A. Grothe, Mr John Leng, Mr T. Meik, Dr Dunsmure, Mr W. B. Page, Mr James T. Smith, Mr Wm. Paterson, Mr James Calder, Mr James Pattullo, Mr Thomas Spowart, Mr John Weir, Mr Hugh Rose; Rev. Mr Connel, Lochee; Col. John Balfour, Balbirnie; Mr Robert Lockhart, Professor Archer, Mr P. W. Dawson, Mr George Cox, Mr Patrick Cables, Mr James Barr, Mr Thomas Greig; Mr John Jeffrey, Kirkcaldy; Mr J. D. Lawrie, Mr John Torry, Mr George Broadrick, Mr John Mayer, Mr J. Woodhead, Mr Andrew Aitkman, Mr Morrison, Mr Alex. Cowan, Mr Peter Cameron; Mr Henry Inglis; Mr Walter Wilson, Hawick; Mr Walter MacLellan; Mr S. N. Morrison, Alloa; Mr Wm. Laird, Glasgow; Mr Anderson, Pettycur; Mr A. J. Adie; Mr T. G. Murray, Edinburgh; Mr W. H. Dickson, Mr George Glendinning, Mr Peter Glendinning, Mr Adam Curror, Mr Robt. Strathern, Mr John Howkins, Capt. Wemyss, Mr James Symon; Mr James Shepherd, Burntisland; Mr A. M. Cunynghame, Mr Wm. Duncan, Mr Charles Tennant, Mr Graham Menzies, Mr Charles Lyell, Mr James Allan, Mr W. H. Beattie, Mr A. J. Dickson, Mr John Stewart, Mr D. Macgregor; Mr Thomas D. Smellie, Glasgow; Mr Thomas Binnie, Glasgow; Mr James Lamb, Messrs Henderson Brothers, Mr John Burns, Mr Leonard Gow, Mr A. A. Laird, Mr Lewis Potter, Mr James Syme, Bailie Scott, Glasgow; Captain Cox, Mr Wm. Drummond; Mr Wm. Reid, Portobello; Mr Samuel L. Mason, Mr George Harrison, Mr A. B. M'Allan; Mr John Sharp, Dundee; Mr John Milroy; Mr Low, Monifieth; Mr Lamond, Crossgates; Mr R. S. Stewart, Dalkeith Road; Mr Hope, Duddingstone; Mr Andrew Tod, Lasswade; Mr Roberts, Westminster; Mr William Tod, Lasswade; Mr M. Langlands, Mr D. Hutcheson, Mr D. M'Brayne, Messrs J. & A. Allan, Mr Kidston, Mr Cuthbert, Mr J. Rankine, Carron Company, Mr Thomas Aitken, Mr J. Currie, Mr M. Gibson, Mr R. Sinclair, Mr George Mathison, Mr W. Thomson, Mr G. V. Turnbull, Mr C. Salvesen, Mr James Cowan; Mr James Lamond, Edinburgh; Mr John Charles Whitten, Sheriff Clerk, Edinburgh; Mr Crole, Inland Revenue, Edinburgh; Mr James Henderson, Ferry-Port-on-Craig; Mr Jas. Mackintosh, Lamancha; Mr R. B. Johnson, Procurator-Fiscal, Edinburgh; Mr Peter M'Lagan, M.P.; Mr W. White Millar, Mr John H. Dickson, Mr Charles Jopp, Mr Henry Inglis, the Right Hon. H. Childers, Mr William Philip, jr., and Mr G. Bruce, Dr Lawrence, Cumnock, &c.

Before commencing the proceedings letters of apology were read from the following noblemen and gentlemen:—Duke of Devonshire, Duke of Sutherland, Lord Wharncliffe, Lord Claud J. Hamilton, Lord Southesk, Lord Rosslyn, Lord Balfour of Burleigh; Sir George Kinloch, Bart.; Sir John Don Wauchope, Bart.; Sir Robert Anstruther, Bart., M.P.; Sir George Campbell, Bart., M.P.; Sir Daniel Gooch, Bart., M.P.; Sir G. Graham Montgomery, Bart., M.P.; Right Hon. W. E. Baxter, M.P.; Right Hon. W. P. Adam, M.P.; Mr James Yeaman, M.P.; Mr Edward Jenkins, M.P.; Mr James William Barclay, M.P.; Sir Alex. Wood, Sir James Ramsden; Mr Archibald Orr Ewing, M.P.; Mr A. Grant, M.P.; Sheriff Crichton; Right Hon. T. J. Boyd, Lord Provost of Edinburgh; Hon. William Collins, Lord Provost of Glasgow; Sheriff Davidson; Sir Wm. Miller, Bart.; Lord Polwarth, Sir James Lumsden; Right Hon. Lyon Playfair, M.P.; Duke of Buccleuch, Sir Sydney Waterton, Right Hon. Lord Colville; Mr Duncan M'Laren, M.P.; and Mr Alexander Mathieson, M.P.

After a splendid luncheon, supplied and admirably served by Mr Russell, of the Royal Hotel,

The CHAIRMAN gave "The Queen," "The Prince and Princess of Wales," and "The Army, Navy, and Volunteers," all of which were received with loud applause. The last-mentioned toast was coupled with and ably responded to by General Ramsay-Stuart, C.B., for the army; Admiral Maitland Dougall, R.N., for the navy; and Colonel Walker for the volunteers.

The CHAIRMAN proposed "The Houses of Parliament," coupled with the names of the Right Hon. the Earl of Elgin and Mr M'Lagan, M.P. (Applause.)

The Earl of ELGIN said—Mr Chairman and gentlemen, I have the honour of replying to the toast which has just been proposed, and, in the absence of Mr M'Lagan, of returning thanks for both Houses of Parliament. You are aware there are many of our Scotch members of Parliament who would have been proud to be here had they not been detained by their duties in London, and I therefore think it unnecessary to make any further apology for their absence. Many gentlemen here are aware that the Houses of Parliament do a great deal of business which does not appear prominently in the public papers, and a great deal of it has to do with undertakings of the sort the completion of which we have seen celebrated to-day. But there is one thing in connection with these undertakings which the Houses of Parliament do not attempt. They sanction the commencement of such undertakings as the Tay Bridge, but I do not think they ever make any attempt to trace their history subsequently. I think if they were to do so there would be many interesting and somewhat amusing results brought to light. We should see, I have no doubt, a great many disappointed hopes; and see also a great many successful prophecies completed. And I think we should also see very frequently bitter opponents shaking hands and congratulating themselves on the successful completion of the undertakings in which they were associated. I do not know if that was the case with the undertaking which has been inaugurated to-day or not—whether it was opposed strongly or not—but I cannot doubt that there is any citizen in Dundee who will do otherwise than congratulate the Chairman and the Directors on the success which they have attained. (Applause.) And perhaps you will let me say that it is not only the citizens of Dundee who have to congratulate them. I come, gentlemen, from a district which has hitherto been somewhat remote—the western district of Fife. Hitherto when we took our seats in the carriages at Thornton or Stirling we did so with some sort of feeling of resignation that at some time or other we would reach the end of our journey—(laughter)—but I am told that those good

days are now past, and that to-morrow we are to have the beginning of a sort of electric flash through our part of the country, and we are to have express trains which will bring us as close to Dundee and Glasgow as we have hitherto been to Edinburgh. I cannot help congratulating the promoters of this undertaking on opening up a part of the country which I hope will give interest to many when they are brought to it. (Applause.)

Ex-Provost Cox said—It is now my pleasant duty to propose what may properly be regarded as the toast of the day, "Prosperity to the Tay Bridge Undertaking;"—(cheers)—and I only regret that the task has not fallen to one abler than I am to do it justice. Having been connected with the Company from the commencement, and having never faltered in my faith that the work would be brought to a satisfactory and successful conclusion, I may at least claim any merit which is due to a steady and unwavering adherence to the cause. I congratulate the people of Dundee—I congratulate the partners of the Railway Company—and I congratulate the public at large on the successful completion of this great scheme. (Applause.) To Dundee, the opening of the Tay Bridge will form an era in the history of the town; for by it new and important facilities in railway communication will be secured—new sources of traffic will be opened up—and instead of being shunted into a siding, Dundee will find itself in the direct line of through communication. (Applause.) The Tay Bridge supplies one of the missing links to the East Coast route, and when the bridge across the Forth has been completed—as it assuredly will be, now that the success of the Tay Bridge has been established—the entire line of railway communication by the East Coast will be complete; and then passengers from Aberdeen and the North as well as from Dundee will be able to reach Edinburgh, York, and London without changing the carriage in which they started on their journey. Thus will a long felt desideratum in our railway system be supplied. To a town of the commercial and manufacturing importance of Dundee the opening of the Tay Bridge will be of incalculable advantage. (Applause). I may be allowed to say that Dundee has been long distinguished for its energy, enterprise, and public spirit. No town of the same size has made more rapid progress in population, wealth, and commercial position. Look at its mills and manufactories, with its intelligent and industrious working classes—look at its unlimited supply of pure water—look at its public parks—look at its Harbour and Docks with all their appliances and equipments—look at the class of ships which now resort to this port and the valuable cargoes which they bring—look at the spacious streets which are now being formed, making Dundee literally a new town—and you cannot fail to see the importance of such a work as that which we are met this day to inaugurate. (Applause.) One of the immediate effects of the opening of the Tay Bridge will be to shorten the distance betwixt Dundee and the capitals of both kingdoms. Another advantage will be to open up the coal fields of Fife, and so to reduce the cost of one of the great necessaries of life. We will be brought nearer to the busy and industrious population of Fifeshire with its varied manufactures, its agriculture, and its great seats of learning, by all which we cannot fail to be benefited, whilst they may also be the better of us. But the Tay Bridge is to be regarded not only as a great and successful work in its commercial aspects, and as binding together two important counties—rich in their mining, agricultural and manufacturing resources—but as a wonderful engineering achievement. The Tay Bridge may be justly considered one of the greatest and most successful feats of engineering genius of our age. (Loud applause.) It is the longest bridge spanning a tidal river in the world, extending about two miles in length, and constructed on the most improved principles of engineering science. On an occasion like the present, I feel the greatest pleasure in referring to the eminent genius,

skill and inventive powers of our distinguished engineer, Mr Bouch, who has planned and executed a work on which his professional reputation is securely established. He must be a proud man to-day in seeing his work publicly handed over to the proprietors. (Applause.) And let me add that never was an engineer more fortunate in his assistants. Those to whom the practical carrying out of the plan was committed were men of great skill and capacity, thoroughly bred in their profession, and entirely devoted to the work. Among these I may be excused for specially alluding to my friend, Mr Grothe—a man of remarkable ability, energy, and perseverance. (Applause.) Nor can I omit to acknowledge our obligations to the eminent contractors—Messrs Hopkins, Gilkes, & Co.—whose professional exertions and desire to provide the best materials cannot be over-estimated. But we must not forget that while able heads are required to plan and to guide, willing hands are no less necessary to execute, and the labours of our hardy and industrious workmen are to be remembered with all praise. (Applause.) I might refer to the origin and history of this great undertaking from the time it was first projected up to the present hour, but that is not necessary. The work has been done, and that is the best answer to the sceptics and scoffers who prophesied nothing but evil of our enterprise. They are silenced now, and they have received their appropriate answer. (Applause). I am unwilling to trespass longer on your time, and would therefore, in conclusion, ask you to join heartily in dedicating this toast to the prosperity of the Tay Bridge. (Loud cheers.)

Mr STIRLING, who was received with applause, said—Mr Chairman and gentlemen, allow me to say a few words on the subject of the Tay Bridge. It is now seven or eight years since I addressed an influential meeting in Dundee advocating the cause of the Tay Bridge. I was very well received, and it was unanimously agreed that it would be an immense improvement and an immense benefit not only to Dundee but to the north-eastern part of Scotland. But, unfortunately, the gentlemen in Forfarshire had not faith. I believe they were perfectly satisfied the Tay Bridge would be a great benefit to their county, and especially to the town of Dundee, but they looked upon it as a speculative engine to be used to try and make a bargain with the Caledonian Railway Company, that it was impracticable, and never would be carried out. (Applause.) When we came to ask you for subscriptions—except Mr Cox, who subscribed £10,000—(applause)—we did not succeed in raising £15,000 in the whole of Forfarshire. Now, I have a word to say about that further on to-night. I believe it was not for want of money, but want of belief in the construction of the works, and I must say when we first started it looked very much like a failure. Our first contractor died soon after commencing the contract. It was only when we arranged with our contractors Messrs Hopkins, Gilkes, & Company that the work was really energetically pushed on. (Applause.) The result to us is that it has at least taken two years more to construct than it would have done under ordinary circumstances. I must say that I never lost my faith in the Tay Bridge. We have carried a great deal of traffic from the north of Scotland to the south for many years at rates and at an expense that I believe have left no profit to the North British Railway Company. We persevered in bridging the Tay, as we believed it would be a success. Had it not been my faith in the bridge I should have long ago agreed to the north of Scotland through traffic being made over to the Caledonian Railway Company on the best terms we could make. As it is, we have now opened the bridge, and among the first benefits you will receive is that you will get to Edinburgh an hour quicker to-morrow than ever you did, that you will be brought nearer to Glasgow, and I may say the new route will also be a great benefit to Arbroath. Above all, we have given notice to the Caledonian Railway Company that we intend to run through

trains to Aberdeen on the 1st of July next. We have called upon them to open up the Friockheim Fork again, to give the best possible route, and we have a letter from the manager saying that it will be done. (Applause.) I have long ago told my friends in Aberdeen to have a little patience, and I hope and trust to live to see North British trains come to Aberdeen. (Applause.) We shall not hold out any inducement of competition rates, reducing rates and fares, as the day for that has gone by, but we shall endeavour to give you good service, and we ask you for a fair share of your traffic. (Applause.) I do think, looking to what we have done for the benefit of Dundee and the north-east of Scotland, that we are entitled to look for a fair share of the traffic. Both Companies can live. I believe that Dundee and the north-east of Scotland is a first-rate traffic ground, and I have publicly to thank those gentlemen who have supported us during the time we could not give good accommodation. I have often regretted that we have not been able to conduct our traffic at Dundee in the manner we would have wished, owing to the miserable accommodation at our disposal at the East Station, but I trust we shall now be able to give great satisfaction in this respect. (Applause.) Mr Stirling afterwards proposed the "Provost, Magistrates, and other Public Bodies of Dundee." He said—Gentlemen, this is a toast which requires no recommendation on my part, and it is a toast which will be, I am sure, well received by all present, and especially by all those who are here from a distance. (Applause.) I first knew Dundee forty years ago when, as a young man, I came to visit my friend the late Mr Erskine of Linlathen. At that time a very heavy cloud of commercial depression hung over the town, but soon after passed away. Since then I have had more or less connection with Dundee, and was brought into very close contact with many persons in this district while Chairman of the Scottish North-Eastern Railway Company. As Chairman of the North British Railway Company for the past twelve years I have had very much to do in this quarter, and have frequently met the public bodies of this town in connection with railway matters. All our meetings have been of the most satisfactory character. I have been very fairly met by these gentlemen, and I hope that I have met them fairly. (Applause.) I am exceedingly proud of the great honour you have conferred on me to-day, and I shall in the future be doubly anxious to promote the interests of your good town. I think you have reason to be proud of your town. You have a fine harbour; and I am glad to know that the revenue derived from it last year was above £50,000. The Tay Bridge, which has now been opened, will give you additional facilities for the early shipment of coals, and no vessels coming into Dundee with produce need now go away in ballast. (Applause.) As for public buildings, this room speaks well for you, and I take this opportunity of thanking the Free Library Committee for giving us the use of it. (Hear, hear.) During the past forty years the population of Dundee has been trebled, and although the town, like many other towns throughout all parts of the country, is at present suffering from the effects of dull trade, I have no doubt that when good times return the spirit and enterprise of your merchants and commercial men will be shown. (Applause.) Without further remark I ask you to join me in drinking to the health of the "Provost, Magistrates, and other Public Bodies of Dundee." (Applause.)

Provost ROBERTSON, in reply, said—Mr Chairman, Croupier, and gentlemen, I rise with very great pleasure indeed to respond to the toast which has been so ably proposed by Mr Stirling, and so very heartily responded to by this large meeting. I do assure you, Mr Chairman, it affords me no ordinary gratification and pleasure to be one of this numerous company; and it gives me also great gratification indeed to have the privilege of responding to this toast in a company like the present. (Applause.) It

would be quite out of place on my part to detain this assembly in replying as I would otherwise desire to have done to this toast. You will therefore pardon me if I simply with one or two observations express the sincere gratification—I, as representing the Town Council and other public bodies of this town—which it has afforded us to-day to have witnessed the successful opening of the Tay Bridge undertaking. (Applause.) In name of the public bodies of Dundee I therefore congratulate the Directors of the Tay Bridge undertaking, as well as the Directors of the North British Railway Company, on the great success which has attended their efforts during the last six years in securing for the county of Fifeshire—and I may say for the county of Forfarshire also—a connecting link that shall at no distant time result in an increase of trade to these two counties never enjoyed in the past. (Applause.) I assure you, Mr Chairman, it afforded me extreme pleasure to witness to-day the opening of the Tay Bridge, as I anticipate that results shall flow from the opening of it that shall greatly promote the welfare of this town, and also the welfare of the county of Forfar. (Hear, hear.) I am happy to think, at all events it was in accordance with my own view of the whole question, that the opening of this railway shall equally promote and redound to the great benefit of the railway systems who have undertaken this great work. (Applause.) I do fondly anticipate that I shall live to see the completion of the other equally noble structure which it is proposed soon to commence—namely, the bridge across the Forth. (Applause.) By the time we have the Forth Bridge erected we shall have a connecting line of railway from the north of Scotland to the south of England, and a line of railway that will not be superseded. We shall then be able to shorten the route between London and Aberdeen, and the convenience of travellers will be promoted, and the shorter route will be found of immense advantage to the general public. (Hear, hear.) I am sure that the working of this new line will bring profit to those who have been instrumental in its promotion. Without detaining you further, allow me again to thank you, sir, and all present, for the cordial reception they have given the toast of the Provost, Magistrates, and other public bodies of Dundee. (Applause.)

Sheriff BELL, who rose amid applause, said—I have the honour to propose the prosperity of the Scotch burghs. (Applause.) That toast has been committed to me not in my individual capacity, but as being the humble representative of the authorities of Fife, and I take the liberty of thanking Ex-Provost Cox and our other hospitable entertainers for the opportunity they have given us of being here to-day and taking part in the opening of this great undertaking. (Applause.) In Fife we have many Royal burghs—more than in any other county of Scotland. One Royal burgh is the venerable seat of a time-honoured University, another was the ancient residence of Scottish Royalty; others show the commercial prosperity of the nineteenth century, and others again in their quaint antique architecture recall times when Scotland was an independent kingdom. (Applause.) All these have for years been linked together by one line of railway, and to-day we are to celebrate the completion of a new link by which they shall be united to their sister burghs on the north of the Tay, and I venture to prophecy that a new career of prosperity will be opened up both for the burghs of Fife and the burghs on the north side of the Tay. I rejoice also to hear that the time is not far distant when a bridge at another end of this line is likely soon to be begun by which the burghs south of the Forth may be more closely united to us than they now are, and by which we shall be conveyed to Edinburgh by road instead of by steamer. (Applause.) I have with these remarks to propose prosperity to the burghs which are now so happily united to-day, and it is my privilege to couple with the toast the name of a representative of a Royal burgh in the north, and a representative of the western metropolis—the Lord Provost of Aberdeen and Bailie Scott, of Glasgow. (Loud applause.)

Lord Provost JAMIESON said—Mr Chairman, Mr Croupier, my Lord, and gentlemen, I rise with the greatest possible pleasure to respond to the toast which has been so eloquently proposed by Sheriff Bell. I have very little to add to what has been so admirably said in regard to the burghs of Scotland. You are very well aware the Scottish burghs have been really the means of preserving our civil and religious liberties; you are very well aware that for whatever of moral and material prosperity exists in Scotland we are indebted to the burghs, and I am sure that those burghs to the north and to the south are exceedingly interested in the proceedings of this day. For myself I feel very much honoured by having been invited, and I had no hesitation whatever in coming away from my own town for the purpose of participating in your enjoyment. This Bridge is unquestionably a great undertaking, an undertaking that reflects the greatest possible honour on the gentlemen who have taken the principal part in its promotion. It is an undertaking also which reflects the greatest honour upon Scotland, and I may say that the magnitude of this structure is not only unique in Scotland but in the world. I have the fullest assurance that the burghs which are to be more immediately connected by the formation of this Bridge will derive important advantages from it, and there can be no question whatever that Aberdeen will also reap advantage from the enterprise which has distinguished those who have been connected with the projection and completion of this wonderful structure. (Applause.)

Bailie SCOTT said—I am here as the representative of Glasgow in the absence of Lord Provost Collins, who cannot be with us to-day, being engaged in those heretical proceedings which are presently occupying so much of the attention of Glasgow. (A laugh.) I am sure, however, that he appreciates with myself the honour which you have done the city which we have the privilege to represent. Glasgow is never behind any town in its enterprise and public spirit; its great improvement scheme, its efforts to advance navigation demonstrate how justly it is entitled to occupy the high position in which it stands. I have no doubt whatever that the construction of this Bridge will connect the north and west parts of Scotland more closely than they have ever yet been. I have been delighted with the splendid situation of Dundee to-day, and I have no doubt whatever that this Bridge will attract to the town many who probably would not otherwise have visited it; while its importance to the commercial interests of the country can scarcely be overestimated. (Applause.)

Mr STIRLING—The toast which I have to propose is "The Chairman of the Joint Committee of the Tay Bridge Undertaking, the Shareholder's Representatives," and with it I couple the name of your Chairman, Mr Cox. (Applause.) I had the pleasure of making Mr Cox's acquaintance some eight or ten years ago when he first joined the North British Board. My intercourse with him has been of the most agreeable description. You all know the large works he and his brothers carry on in the neighbourhood of Dundee, and the care and attention required to carry on those works, which are one of the sights of Dundee, and where he employs 5000 hands. During the ten years Mr Cox has been a Director of the North British Railway Company he has always found time to carry out anything I have asked him to do. Not merely at the Board meetings, but on any occasion and at any time Mr Cox has been at the call of the North British Board. As for the Tay Bridge it is a special pet child of his own. I believe he has thought of it and dreamt of it, and nothing else, for the last ten years—(laughter and applause)—and I am very glad to congratulate him on the birth of his pet child to-day. (Applause.) Along with Mr Cox we have other representatives of the shareholders, your senior Member of Parliament, Mr Yeaman—(applause)—who I regret extremely is not here to-day, as he has taken a warm interest in the Tay Bridge from the commencement, and Mr George Clark, of Glasgow, who has been a very active and useful member of the Tay Bridge Committee. (Applause.) As time is

pressing, I will not detain you, but give my toast, "The Chairman of the Joint Committee of the Tay Bridge Undertaking and the Shareholders' Representatives." (Applause.)

The CHAIRMAN, in reply, said—I have to thank Mr Stirling for the kind manner in which he has proposed my health, and I have to thank you, gentlemen, for the kind manner in which you have received the toast. I must candidly confess that I feel somewhat proud of the work in which we have been engaged this day. (Applause.) I was one of the original promoters of the Tay Bridge, and I have taken a considerable interest in its progress from first to last. My services have been amply rewarded by the success which has attended the undertaking; and I fully appreciate the honour of presiding over this great assembly. (Loud applause.)

Provost ROBERTSON—Mr Chairman, Croupier, and gentlemen, I rise again with great pleasure to give the next toast on the list, that of "The Railways of the United Kingdom." (Applause.) I can scarcely, indeed I cannot, define at all the reason why my name has been associated with this toast if it be not that the important burgh, of which I have the honour at the present time to be Chief Magistrate, is to receive the greatest benefit by the work which we have this day been inaugurating. The magnitude and importance of the railway interests throughout the United Kingdom are such as to be almost beyond comprehension. I am not a railway man myself, and for reasons well known to myself I have refrained from holding any connection with any railway company in the kingdom up to the present time. While I might with profit to myself have been connected with the railway systems, I found it was for my interest while serving the community of Dundee that I should be free and unfettered. (Applause.) It may be known to most of those present, but to some it may not be known, that at the present moment there is money expended on the railways throughout the United Kingdom in amount equal to the National Debt of England, and it may not be known to many present that over the whole of the railway system of the United Kingdom during the past year there had been carried 560,000,000 of passengers. (Applause.) Now, gentlemen, if you consider the ramifications of the whole railway system throughout the United Kingdom and the immense number of passengers carried, you cannot but wonder how the traffic can possibly be carried on with so little loss of life, indeed with so few accidents. (Applause.) But more particularly with regard to the toast, I am not overlooking this fact, that we in Dundee only know, at least particularly, two great railway systems—the one being the North British railway system, in whose interest and at whose call we have the pleasure of being assembled here to-day, and the other that of the Caledonian Railway. (Applause.) At the hands of those two Companies I cannot say that up to this moment Dundee has occupied a very enviable position, but I can say that for many years past to my certain knowledge the North British has strenuously desired to put it in a position which it ought to occupy on any railway system. (Applause.) And I am proud to-day, and I have already expressed my pride and satisfaction, in having witnessed the connection of the two great counties already referred to, and to see Dundee not so much on a siding as it has formerly been. (Applause.) I hope still to see Dundee on the main line of the North British Railway, and I should not regret at al to see the day when it is also placed on the main line of the Caledonian system: and if I had had my way—and I still think I was right in advocating the promotion of a central station for the town—we would have passed the time when Dundee was on a siding, and as regards both of these immense systems of railway we should have been on the main trunk line to London and the north. (Applause.) Gentlemen, as our worthy croupier, Mr Stirling, has well said, he does not desire to see a rivalry rising between those two railway systems whereby the traffic may become unremunerative

to the shareholders. Neither do I; but I do desire for this community—and I am sure I only express the sentiments of those gentlemen present—that we should have fair competition between them. (Applause.) I am glad, called upon unworthy as I am to propose this toast, to associate with it the name of a gentleman closely connected with the other great railway system in our neighbourhood—namely, Mr John Sharp, of the Caledonian Railway Company. (Applause.) It is not more than fifty years, at all events, since the first railway opened between Liverpool and Manchester, and you know now what a network of rails Great Britain has become. No one, I am sure, can look upon the network of rails throughout the United Kingdom and witness the enormous traffic carried over these lines without wondering and becoming amazed beyond measure how it was possible for the traffic of the country to be performed without railways. That may astonish us, but I am hopeful there are still better experiences in prospect for the railway systems of the United Kingdom than anything preceding; and when we have learned to consolidate the whole of these systems as they ought to be the traffic will be increased, the rates will be remunerative, and those whose money is invested and sunk in railways shall realise fair dividends. I am sure I sincerely wish all success to the railway systems of the United Kingdom, and I couple this toast with the name of Mr Sharp. (Loud applause.)

Mr SHARP, in reply, said—Mr Chairman, Croupier, and gentlemen, I feel indeed highly honoured by having my name coupled with this most important toast—coupled with the largest commercial system in Britain—the railway interest. I should presume there is scarcely one in this hall who is not personally in one way or another connected with it, whether as a shareholder or as reaping benefits from it in another way. I think it would be entirely out of place were I to follow the remarks Provost Robertson has made, or to bring up any comparison betwixt the two rival Companies which come into this town. (Applause.) As a citizen of this town I congratulate the North British Company on their achievement of to-day, and, gentlemen, as a Director of the Caledonian Railway Company, I am sure I only state what is the feeling of every member of that Board when I say that we will hail this as an incentive to do our best still further to secure the favour of the public. (Applause.) We wish a free field for both Companies. We wish to extend our system as far as we can, and why should not our neighbours do the same? Whoever serves the public best let them have the benefit. (Applause.) Gentlemen, I was very much pleased indeed to listen to the remarks made by Mr Stirling this day when he stated that he wished no rivalry such as would be ruinous to the shareholders of both Companies. I sincerely sympathise with him, and I am sure so shall the other members of our Board; and if there is such a rivalry it will be one much to be regretted. (Applause.) I hope and trust this will be the commencement of a new era, that we shall sink any minor difference, and that our only object shall be to serve the public aright. (Applause.) Gentlemen, as a citizen and as one engaged in the business of this town, I would desire just to say a word. At present our trade is in a very depressed condition, and this is not perhaps the best time that might have been for success to appear at once; but while I say that I am glad to think that, compared with other towns in the country and other industries, we have no cause for complaint, and when prosperity comes to the other industries of the country I expect we shall not be behind. (Applause.)

Sir JAMES FALSHAW gave "The Lord-Lieutenants and the Sheriffs of Fife and Forfar." (Applause.) He said—By the work which has this day been inaugurated we have brought the two counties of Fife and Forfar more closely together. (Applause.) Before they were separated by the breadth of the noble and silvery Tay, but now we have bridged over the Tay, and brought Fife into Forfar and Forfar into Fife. (Applause.) After referring in felicitous terms to the absence of the Lord-Lieutenants of Fife and Forfar,

Sir James remarked that they occupied important positions, and they were responsible, too, for keeping down rebellion. (Laughter.) Whether Lord Beaconsfield was right or Mr Gladstone was wrong, he was glad to see that we were likely to have peace. (Applause.) At any rate, they had done what they could to make peace between Fife and Forfar. (Laughter.)

Sheriff HERIOT, whose name was coupled with the toast, said—I have come here to-day at considerable inconvenience, because I considered that the opening of the Tay Bridge was a great public event in the history of Dundee. (Applause.) Dundee has hitherto been very much shut out from the south. Now we are to have a good access, and it is a matter of the utmost importance that we shall have our railway journeys so much shortened by the opening of this Bridge. (Applause.) At present few tourists come to Dundee, but this Bridge, which is the longest in the world—one of the greatest engineering feats of the age—will attract many people to see it, and they will also come to Dundee. (Applause.)

The Rev. Mr RAE, minister of the united parishes of Kinloch and Lethendy, near Blairgowrie, said—Mr Chairman, Croupier, and gentlemen, when I was asked to propose the toast that has been committed to my care, "The Directors of the North British Railway Company," I certainly felt highly honoured, but I felt at the same time that it would have come with a better grace and with more weight had it been submitted to your notice by one of the mercantile and manufacturing princes of this town. But this I can say, that no one wishes the success of the Company more heartily than I, or who is more thankful to the Directors for the anxious care and the untiring zeal with which they have managed our business through seasons of great depression, and in the face of difficulties of no ordinary kind. (Applause.) The Directors of the North British Railway deserve, and I believe they have, the gratitude and the confidence of that great body —ay, of the whole of the shareholders—for the able manner in which they have always conducted the affairs of this Company. (Applause.) They have by a wise, and perhaps occasionally by a large, but always a necessary outlay, and by a wise economy on other occasions—by a bold policy when boldness was necessary—by a cautious policy when caution was necessary—secured the goodwill of the shareholders. (Applause.) They have never despaired of the ultimate fortunes of the Company even when they were at their worst; and when they had nothing better to give, they always gave a word of cheer and a promise of a better time coming to desponding shareholders when dividends fell to zero or vanished altogether. (Applause.) They deserve the gratitude of the public at large for the readiness which they have always shown to open communications with fresh centres of industry, and for the facilities they have provided for travelling through no inconsiderable portion of our romantic land, and for the facilities for carrying these commodities which contribute alike to national and individual wealth and comfort. (Applause.) But, gentlemen, it would be unpardonable if it were not impossible on such an occasion as this to omit saying they deserve the gratitude of a more select body still than the shareholders and the public at large. I mean that noble band of workers who, with wise head and busy hand, are doing what they can to promote the progress of physical science and to extend the dominion of man over the powers of nature. (Laughter and applause.) They set themselves to grapple with and to overcome difficulties of no ordinary kind, physical difficulties which seemed absolutely insuperable, and financial difficulties hardly less so; but notwithstanding all they commenced that work, and commenced it in spite of cold encouragement from some quarters—(laughter)—and bitter ridicule, I recollect. (Applause.) But with the patient, persevering resolution of men who had confidence in themselves, confidence in the engineering genius of Mr Bouch, who we all regret is not present to-day to receive his civic Crown—(applause)—confidence, too, in the thorough feasiblity of what to many looked like a wild chimera, they have carried successfully through,

and yonder it stands—and may it stand for long ages—one of the grandest undertakings ever planned by human brain or executed by human hand. (Applause.) The successful completion of the Tay Bridge incites and encourages, as we have heard to-day, the speedy commencement of a still more formidable undertaking, for until that undertaking is completed, and uninterrupted communication is secured for our system from end to end, the North British Railway will never occupy the position which it ought to occupy, or be able to meet her great rival in the gates on something like a footing of equality. (Loud applause.) But no doubt such gigantic undertakings as the Tay Bridge must have laid a burden of responsibility and care heavy to be borne on the shoulders of the shareholders, and the ordinary management of such a large concern as ours must give them many an anxious thought. No doubt so long as human nature is human nature there will be grumblers—grumblers to the end of time. Let them give no heed to these unreasonable grumblers; let them only continue to do their duty faithfully, firmly where firmness is necessary, and cautiously where caution is necessary. (Applause.) And if Mr Stirling and the other Directors will permit me to say it, where a policy of concession to the reasonable body of the public is made, and they always yield, not grudgingly, but with good grace, and at the right time, if the Directors may not be able always to command that success which is due to their best laid schemes to secure harmony in the occasionally conflicting interests of their constituency and the community at large, they will at least command that success which is never denied to men who have tried to do their duty in the circumstances. (Applause.) Allow me to propose the toast committed to me, "The Directors of the North British Railway Company," coupled with the health of our indefatigable Chairman, Mr Stirling. (Applause.)

Mr STIRLING, who was received with applause, said—I hardly know how to return thanks for the toast which has just been given, and for the manner in which you have just received it. There is no doubt that the North British Directors had a very anxious time of it for the last twelve years. When I had the honour of being appointed Chairman of the North British Board the Company was almost in a state of bankruptcy. I wish the public to remember that the North British Company has been a struggling Company for the last twenty years, that it is made up of five or six different Companies, none of whom were eminently prosperous. The plant of every Company was different. Even the rails on each section were different, and we have had a very large amount of work to do in trying to bring them into uniformity. This will account for some of the shortcomings that the public have to complain of. You cannot change five or six different systems at once, but we expect that in a few years the North British shall be able to take its proper place amongst the railway Companies in Scotland. (Applause.) I have been connected for thirty years with railway Companies. Unfortunately I have always been connected with struggling Companies. Both those I have been Chairman of came to a successful issue, and I have not the least doubt that the North British Railway Company will do so as well. (Applause.) There have been various complaints amongst some of the shareholders that we did not begin to the Forth Bridge sooner, that we have not pushed on the Arbroath and Montrose lines sooner; but as I said before, the public had not faith in the Tay Bridge, and I told the shareholders we would move in nothing more till the Tay Bridge was an established fact. I ask you now to have some confidence in the Forth Bridge. (Applause.) I do not profess to be an engineer, but I have cross-examined Mr Bouch in every possible way, and I have great confidence in his judgment, and I think the work you have seen to-day should give you also confidence in his judgment. (Applause.) I have talked to some of the best engineers in England on the subject of the Forth Bridge, and they believe it to be as practicable and as certain of accomplishment as the Tay Bridge. (Loud applause.) I do trust, if I am spared to be Chairman

of the North British Railway Company, that many of the gentlemen I see here to-day will be at the opening ceremony of the Forth Bridge. (Applause.) I think we shall appeal to the shareholders and to gentlemen in Dundee and the north of Scotland to support us by taking stock in the Forth Bridge, and I hope and trust, looking to what we have done in the Tay, they will believe that we can bridge the Forth. (Applause.) There has been a strong expression of opinion by some gentlemen in Dundee that there should have been a great demonstration on the occasion of the opening of the Tay Bridge. It is impossible to have anything of that sort at present on such short notice; but I shall recommend my colleagues to do something at the Dundee holiday-time in the way of illuminating some of the centre arches on an extensive scale, and much more to the satisfaction of the Company and the public than could be done at present. (Applause.) While I act as Chairman for the North British Company, I would take this opportunity of saying that whatever a Chairman can do is futile unless he is well supported. I have been admirably supported in the direction. I have always found the Directors willing to work for the North British interest; and above all we have had a most efficient staff of officials. (Applause.) One and all devote themselves to promote the prosperity of the North British Company. Foremost among them I cannot help mentioning our excellent General Manager, Mr Walker. (Applause.) I am extremely sorry Mr Bouch is not here to-day. I believe if possible he would have been present, but I think we owe him a debt of gratitude for the ability, care, and attention he has bestowed on the Tay Bridge. (Applause.) I will not detain you longer, but will simply render you my best thanks for the kind manner in which our healths have been proposed and in which you have received them. (Applause.)

Mr GEORGE HARRISON proposed "The Manufacturing and Mercantile Interests." He said—Those connected with commerce have for some years been severely tried, and if they had not in good times accumulated a little capital I am afraid their prospects would have been even more gloomy than they are. I should be glad if the working classes would take an example from those connected with the mercantile interests of the country and accumulate their capital through some other agency than a Trades' Union. (Applause.) I am glad, however, to see that in good times they do accumulate capital even in the funds of Trades' Unions. I will not detain you farther. I have great pleasure to be present in this great manufacturing city of Dundee to-day, and to witness the union of the important agricultural counties of Fife and Forfarshire. (Applause.)

Mr W. M'LELLAN, whose name was coupled with the toast, replied. He said—In no period of our country's history have the mercantile and manufacturing interests of the country engaged so much of the attention and thoughts of all parties; and although I take no gloomy view of the situation myself, still I am satisfied that the dark cloud which is hanging over us is of a thundery character, and will probably soon break and pass away. The commercial interests depend upon the result of our agricultural pursuits—namely, a good harvest. A statement appeared during the week in one of the newspapers to the effect that for the whole manufacture of the united works of Europe 7,900,000 tons of iron were used in 1875. In 1876 there was a falling off of 1,200,000 tons, and taking that at £3 10s per ton we have £4,000,000, and comparing that with the agricultural interest of Scotland alone I find that the loss is altogether between £9,000,000 and £10,000,000. I only wish I could say that there was an immediate prospect of the cloud passing away, but such works as those we have seen inaugurated to-day prove the energy and enterprise of the country, and I have no doubt that we shall soon have better times. (Applause.)

Sir JAMES FAILSHAW proposed the "Contractors of the Tay Bridge and Railways and the Resident Engineers," coupled with Messrs Gilkes, Waddell, and Grothe. (Applause.) He said—This toast is one of the most

important on the list. I ask you where you would have been to-day but for the exertions of the gentlemen who were entrusted with the practical execution of the works? (Hear, hear, and applause.) The Bridge has been completed by Messrs Hopkins, Gilkes, & Co.; and the firm were, in my opinion, very wise indeed, when they retained the services of Mr Grothe as resident engineer. He began the structure, and he has had the satisfaction of bringing it to a successful issue. Messrs Hopkins, Gilkes, & Co. provided the material, and they never flinched one iota in carrying out the work, and Mr Grothe and the others who have occupied very important positions in connection with the structure have brought to bear a strength of heart and energy of purpose and a zeal above praise. (Applause.) Mr Waddell has also carried through the supplementary parts of the work and the approaches to the bridge in an admirable manner. We might have planned as we liked, but if we had not the scientific power and the energy of Mr Waddell we could not have seen the opening to-day. It is gratifying also that we can say that these works have been brought to a conclusion without reference to the law, without any difficulty in the Court of Session, or without even the calling in of arbitration. (Applause.)

Mr GILKES, in reply, said—I have to thank you very heartily for so cordially responding to the toast. This day you have completed a great work. You have erected a magnificent structure, which I say with the greatest confidence is one of the best bridges in the world. As to who originated the Tay Bridge there has been a good deal of dispute. Some had claimed to have originated the idea; but whoever was entitled to that honour it required Mr Bouch to step forward and show how the scheme could be carried out. (Great applause.) I am sorry Mr Bouch is not present, but I am sure that this is a proud day to him, when this very great work is brought to a happy and successful issue. (Great applause.) In consequence of the death of the eminent contractor, Mr Charles de Bergue, I have had the honour of finishing the work which he began. When I began there were undoubtedly dark days, and but for the manner in which every one concerned had acted the Tay Bridge would never have been opened this day. Many serious difficulties arose, but they were successfully overcome, and now we have the satisfaction of seeing the bridge a completed work. (Applause.) This work was not done without an important staff of assistants, and I cannot allow this opportunity to pass without thanking Mr Grothe—(applause)—and the other members of the engineering staff who have worked so ably and so well in the erection of the bridge. (Applause.) They are all worthy of praise, and they will have my personal regard wherever they are. (Applause.) Mr Gilkes, after referring to the importance of the bridge in a commercial point of view, concluded by thanking all concerned for the great courtesy which had always been shown to him.

Mr WADDELL said—I thank you for the honour conferred upon me as one of the contractors for the Tay Bridge works. I am proud to be associated with such a great undertaking, and I am very much pleased to see the works brought so near completion. With regard to my part of the works, it does not appear to be of any great magnitude compared with the Tay Bridge itself, for, while the bridge has a grand appearance and is exposed to view, the whole of my works are underground and out of sight. (Laughter and applause.) However, so far as the cost is concerned, the value of my part of the works is at least fully as much as the cost of the bridge itself. In reference to the tunnel, it was a work of great difficulty, and men of experience and ability in Dundee told me when I commenced that I should never be able to make a tunnel along Dock Street, as they found that it was impossible for them to keep their cellars dry. But through perseverance and hard work the tunnel has been completed, and is a great success, and I have not the least doubt that it will well answer the purpose for which it is intended. I hope it will be

a great success to the promoters and shareholders of the undertaking. (Applause.)

Mr GROTHE, who was received with loud applause, said—You all know that the performance of any particular piece of work, the discharge of any particular duty, seems to be a much more difficult task at one time than at another, and I feel that particularly just now. I know there is no great difficulty nor any great knowledge required in replying to an ordinary after-dinner toast. It is not a difficult thing, except, perhaps, to a man of extraordinary bashfulness; and, though I may have been bashful at one time since my sojourn in Scotland, I am not now so much troubled with this complaint. (Laughter.) This is, however, not an ordinary day. I have longed and worked for it during the last seven years. It is a day which I often feared would never come, and one which I have looked forward to with grave doubts, and wondered whether I should be alive to see it when it did come; and you may therefore easily understand that I feel a special interest in the proceedings of this day. (Applause.) If, in the excitement of the moment, I should not express myself in terms sufficiently grateful to you for the honour you have done me, I have no doubt that you will understand the reason. I thank you most heartily for the reception you have given me, and I thank especially those gentlemen who have by their countenance and support in many ways helped me during the years I have been engaged in the construction of this work. (Applause.) The gentlemen who gave me their assistance were exceedingly well qualified for the work, as Mr Gilkes has already so kindly mentioned. A finer staff, I believe, no man ever had. (Applause.) I regret that only one of them, Mr Camphuis, is here to-day. They are scattered all over the country like the plant which was brought to the hammer the other day. But I hope that after a good overhaul they will soon all be actively employed again; and I am sure any engineer or contractor who employs them will be as satisfied with them as I had reason to be. (Loud applause.) Then we must not forget the foremen I should like to mention them all by name, but must confine myself to saying that they, as well as the workmen, were as fine a set of men as I shall ever get or want. (Applause.) They had many an opportunity to show their endurance, courage, devotion, and confidence in their officers, and will be glad to hear that we have not forgotten them to-day. (Loud applause.) I might now conclude were it not that in my mind some doubt exists about the meaning of the words resident engineers in the toast-list. Had the powers who made the list the contractors' engineers in view? If so, I must draw your attention to the fact that no mention has yet been made of Mr Bouch's able staff and Mr Paterson, the resident engineer. I regret that Mr Paterson, who is still a convalescent, should have left us, because I should have liked to thank him for all the kindness he has shown us during the progress of the work, and I must draw your attention to the fact that to his splendid management we owe that the settlement between the Company and the contractors was made without having recourse to law or arbitration—a circumstance which is almost without precedent in the history of large works. (Applause.) With these remarks, gentlemen, I cordially acknowledge the kind compliment which you have been pleased to award.

Mr THOS. BUCHAN proposed the health of Mr Yeaman, M.P. He regretted that Mr Yeaman's name was not in the toast list, but no doubt this was an omission. At anyrate, no man had taken a deeper interest in the construction of the Tay Bridge than Mr Yeaman, and he thought they ought to drink his health on that occasion. (Applause.)

A vote of thanks to the Chairman concluded the proceedings.

The tables were tastefully decorated with flowers and plants supplied by Messrs Laird & Sinclair, Nethergate, and a conspicuous object on the table was "The Tay Bridge Sauce," prepared by Mr J. N. Davidson, chemist, Nethergate.

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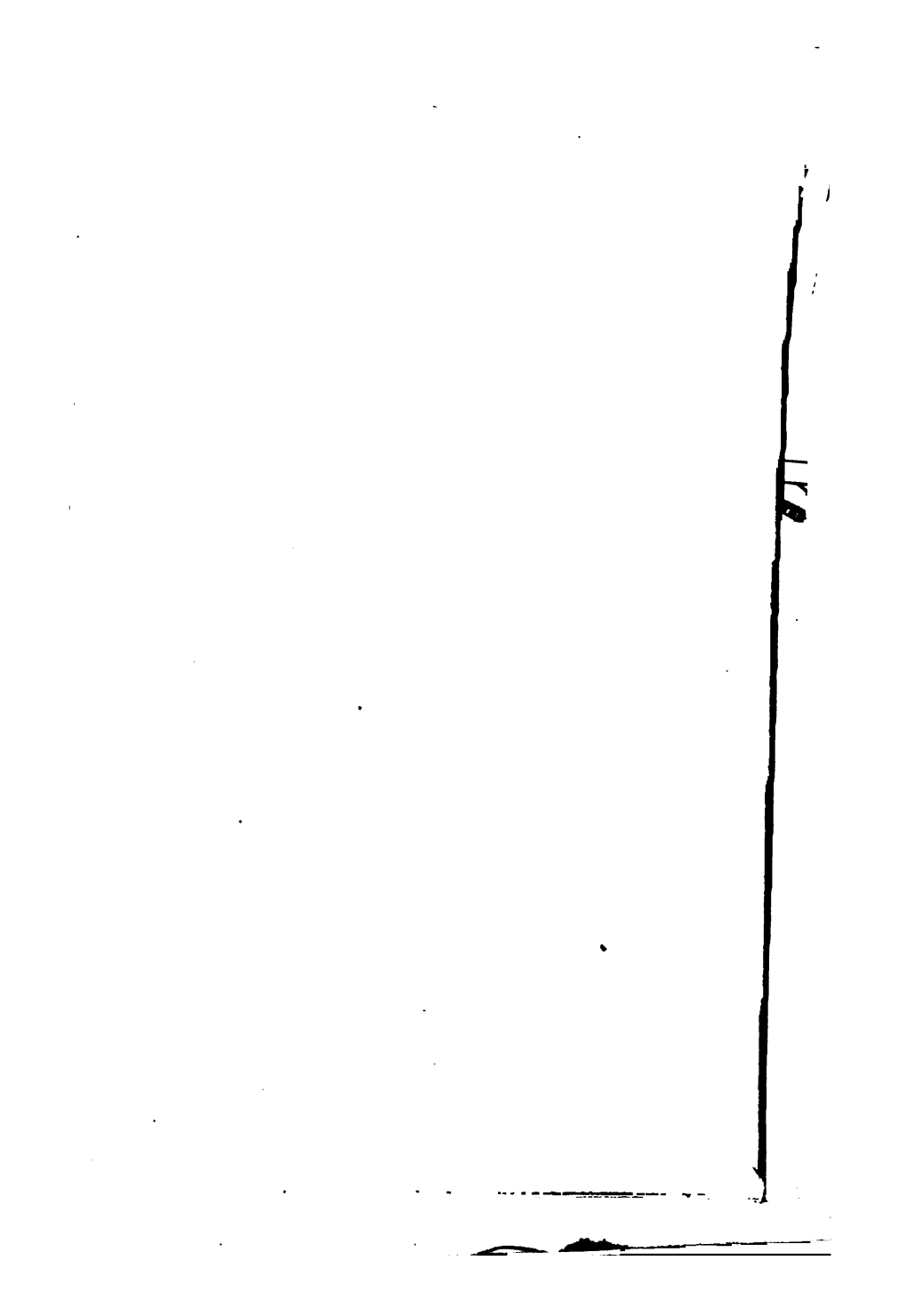

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